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ABSTRACT

This document presents a compilation of marine sciences institutions, academic degrees, curricula, teaching and research facilities, and teaching faculties at 134 academic institutions throughout the country. In addition, the document gives the typical requirements for admission to graduate study and information concerning financial assistance programs. The various curricula include curricula in the marine sciences and related fields; consortia in marine science; curricula in ocean engineering; curricula in fisheries; curricula in marine law; curricula for maritime officers; and curricula for marine technicians. An appendix presents the institutions by geographic location. (HS)

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# *UNIVERSITY CURRICULA*

# *IN THE*

# *MARINE SCIENCES AND RELATED FIELDS*

## *ACADEMIC YEARS*

## *1971—72 AND 1972—73*

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*PUBLISHED BY*

*THE*

*OCEANOGRAPHER OF THE NAVY*

***PAMPHLET # 43***

***AUGUST 1971***

HE 003097

# *UNIVERSITY CURRICULA*

# *IN THE*

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*ACADEMIC YEARS*

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Each institution is described by the type of degree program it offers: U = undergraduate; G = graduate. Where other types of programs are indicated, please consult the institutional listing for detailed information.


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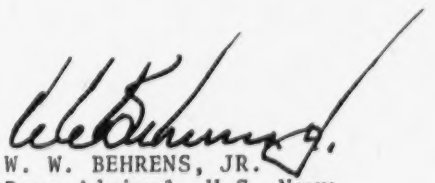
# FOREWORD

This report contains information on a wide diversity of curricula offered at 134 academic institutions throughout the country. It is published by the Oceanographer of the Navy in the hope that it will be of assistance to students in planning careers in the marine sciences.

The Oceanographer is grateful for the cooperation of the many administrators and faculty members of the institutions who supplied the information for this report.



W. W. BEHRENS, JR.
Rear Admiral, U.S. Navy
Oceanographer of the Navy

## INTRODUCTION

This compilation of marine sciences institutions, academic degrees, curricula, teaching and research facilities and teaching faculties is based on information supplied by the institutions in response to questionnaires sent by the Office of the Oceanographer of the Navy. Only those institutions which responded to the questionnaire are included.

In the title of this document the term "marine sciences" refers to academic programs in oceanography, marine science and ocean engineering; these program areas place significant emphasis on the oceans. The distinction between "oceanography" and "marine science" reflects terms used by the institutions themselves. Generally, "oceanography" is considered a multidisciplinary science, whereas "marine science" refers to the marine branch of a particular scientific discipline - i.e., geology, chemistry, biology, etc. The titular term "related fields" refers to academic programs for training ships' officers and maritime engineers, naval architects, marine lawyers, marine (science and engineering) technicians, and applied fisheries scientists and technicians.

The omission in this report of degrees in fields other than marine sciences does not in any way imply that a system of training which culminates in a marine sciences degree is superior to that which channels training through the more traditional scientific or engineering disciplines. Students with a primary interest in a classical discipline may wish to investigate its possibilities in relation to ocean-oriented work.

This booklet is not intended to provide a detailed description of each academic program nor is it to be considered a compilation of official college catalogs. Prospective students are strongly urged to obtain further information directly from those institutions in which they are interested.

Programs of the institutions which responded to the questionnaire have been placed in one or more of the six major sections of this report: Marine Science; Ocean Engineering; Maritime Officers; Fisheries; or Marine Technician; or Ocean Law. Institutions included in the marine science category offer at least fifteen semester hours or equivalent of primarily ocean-oriented courses. Some 104 institutions have joined forces into nine regional consortia, i.e., nine partnerships which jointly support and use a common shore laboratory for research and educational purposes. These consortia programs are separately noted. All of the institutions which reported offering ocean engineering programs are included, as are those offering marine-related training programs in or for maritime operations, technicians, and fisheries science and technology.

A standardized format has been followed in describing all of the programs. Institutions are listed alphabetically in each of the six program areas. Each institutional program is described in terms of its teaching and research facilities--laboratories, classrooms, ships, computers, etc.--and its academic programs and staff. Degrees offered and degree requirements of the institutions are described. Academic courses are listed by department name, course number and title, and credits per course; departments and course descriptions are as used by the institution. Credit hours are in accord with each institution's system, either semester or trimester/quarter. Three trimester hours equal two semester hours. Faculty are listed in alphabetical order by department. Each faculty member is listed with his rank reported at the time this pamphlet was prepared and with his or her highest academic degree earned. The name and address of the person to whom to direct inquiries is noted lastly for each institution.

## TYPICAL REQUIREMENTS FOR ADMISSION TO GRADUATE STUDY

The formal requirements for admission to graduate study in marine science and ocean engineering vary greatly from one institution to another. However, basic minimum requirements can be identified as common prerequisites to admission.

Oceanography and Marine Science: The general requirements for admission to graduate schools are as follows:

(1) A baccalaureate degree from an accredited college or university with a major in biology, chemistry, engineering, geology, mathematics, oceanography, or physics.
(2) A cumulative undergraduate grade average of approximately "B" (or 3.0 on a 4.00 scale).
(3) Mathematics through differential and integral calculus.
(4) One year of chemistry, with laboratory.
(5) One year of physics, with laboratory.
(6) One semester of geology, with laboratory.
(7) One semester of biology, with laboratory.
(8) A broad background in the humanities.

It should be noted that these minimum requirements may be modified or waived for admission to a specific program. Students whose backgrounds do not include all of the required courses may in some cases be permitted to complete prerequisite courses, whether prior to or after admission to graduate study.

Satisfactory completion of additional courses such as the following is regarded as highly desirable for admission to study in particular disciplines: advanced calculus, differential equations, thermodynamics, organic chemistry, historical and structural geology, and vertebrate and invertebrate zoology. For admission to a specific discipline within the marine sciences the student should have an undergraduate major in the same or a closely related discipline, with appropriate minors. For instance, for admission to study in physical oceanography a student should have had a major in physics and a minor in mathematics or vice-versa.

Ocean Engineering: For students applying to graduate ocean engineering programs, requirements are not as clearly specified as those for the marine sciences. Broad general requirements can be identified as:

(1) A baccalaureate degree in engineering or science from an accredited college or university.
(2) A cumulative undergraduate grade average of approximately "B" (or 3.00 on a 4.00 scale).

(3) Mathematics through differential equations.

Satisfactory completion of additional courses in mathematics, especially in advanced calculus, probability, and statistics, physical and life sciences, and economics is highly desirable.

Other requirements commonly include the taking of the Graduate Record Examinations and submission of recommendations from major professors. Deadlines for submission of applications and the schedules for fees vary greatly from institution to institution.

## FINANCIAL ASSISTANCE PROGRAMS AVAILABLE FOR COLLEGE STUDENTS

### Programs of Department of Health, Education and Welfare

National Defense Student Loan Program. Under this program, supported by the Federal Government and administered by the participating colleges, students at all levels--from high school graduate to Ph.D. candidates--may be eligible for long-term, low-interest loans.

High school graduates who have been accepted for enrollment by participating colleges and universities, as well as graduate and professional students who are enrolled at least half time, and who need financial assistance are eligible for student loans.

An eligible undergraduate may borrow up to $1,000 each academic year--to a total of $5,000. An eligible graduate or professional student may borrow as much as $2,500 each year to a maximum of $10,000. Repayment need not begin until nine months after the student leaves college. Interest on the loan is three percent per year. Up to fifty percent of the loan may be cancelled or "forgiven" at the rate of ten percent for each year the borrower teaches in a public or other nonprofit elementary or secondary school or in an institution of higher education in the United States. The total loan may be cancelled at fifteen percent per year for teaching in certain schools in low-income areas.

College Work--Study Program. This program, supported by the Office of Education and administered by the participating colleges, provides students with an opportunity to earn part of their college expenses by working within the college or university or for a public or private nonprofit organization. While classes are in session, a student may not work more than fifteen hours a week. During vacation periods, a student may work forty hours a week.

Guaranteed Loan Program. Under this program students in attendance or accepted for admission in accredited institutions are eligible to borrow for college or vocational training expenses from participating banks or other commercial lenders. In general, depending upon the state in which they live, students may borrow up to $1,500 per year. For students whose adjusted family income is less than $15,000 a year the Federal government will pay all interest charges (up to a maximum of seven percent) during the time they are in school and before the repayment period begins some nine to twelve months after studies are terminated.

Educational Opportunity Grants Program. This program, authorized by the Higher Education Act of 1965, provides for grants ranging from $200 to $1,000 to students of exceptional financial need for each of the four years of undergraduate study. Colleges participating in the program determine the student recipients of the grants and the amount required by the student. Any student in extreme financial need who has been accepted for admission at a participating college or who is already enrolled and in good standing is eligible to apply for a grant.

For further information on these four programs, write to the U.S. Office of Education, Division of Student Financial Assistance, Washington, D.C. 20202.

### Programs of the Veterans Administration

Junior GI Bill. Under provisions of the Junior GI Bill and its recent amendments, educational allowances are paid to children (generally between the ages of 18-26) of veterans who were permanently or totally disabled, who died as a result of service in the U.S. Armed Forces, or who had peacetime service after the Spanish American War and prior to September 14, 1940.

Veterans Readjustment Benefits Act of 1966. This Act provides educational opportunities for qualified servicemen or women who have served in the Armed Forces on active duty for more than 180 days any part of which occurred after January 31, 1955, and for servicemen or women currently on active duty. For those veterans, any part of whose service occurred between January 31, 1955 and May 31, 1966, eligibility ends on May 31, 1974. For all veterans who served after May 31, 1966, eligibility ceases at the end of eight years after the date of the veteran's last release from active duty. Assistance is available for a maximum of 36 months. Monthly payments vary with the type of training being sought and the number of dependents.

For further information on these two programs, write to any organization for veterans or your nearest Veterans Administration Office.

Reserve Officer Training Programs (ROTC). The Army, Navy and Air Force conduct reserve officer training programs at selected colleges and universities. Financial assistance grants are available to selected students. After completion of one of these programs, the student agrees to serve a stipulated period of time in the military service. Inquiries should be directed to the Chairman of the Department of Military Science of the institution in which the student plans to enroll or to the Department of Defense, Washington, D.C. 20301.

Other Federal Scholarship or Grant Awards. Some Federal agencies provide financial support to students, both directly and indirectly. One such program is that of the Maritime Administration of the Department of Commerce which provides state maritime academies with $600 per year for each student enrolled. This money is deposited in the student's account at the academy to be used for books, uniforms, etc.

In addition, Federal agencies support marine research programs at many universities. These programs provide financial

support for graduate students in the form of assistantships, research fellowships, grants and teaching stipends. Applications for such financial support should be made to the institution.

State Programs. A majority of the states and Puerto Rico sponsor financial assistance programs for undergraduate and first professional degree students. The amount and form of assistance as well as eligibility requirements vary among the states. The amount of aid often depends upon such factors as family income and other assets. To be eligible for assistance, students may be required to pass examinations, have superior academic records, or be enrolled in specific fields. Forms of assistance include loans, scholarships and grants-in-aid. Further information on State sponsored programs may be obtained from high school counselors and State departments of education. Some specific sources of financial assistance are noted in the "Need A Lift" publication listed below.

Nongovernmental Scholarships and Loans. Financial assistance programs maintained by local, state, and national units of social, civic, religious, and fraternal organizations provide loans and scholarships to outstanding and worthy students. In addition, many national scholarships are awarded through specific colleges to qualified students by large corporations and foundations.

The following publications provide information on other available assistance programs and may be obtained from the indicated offices.

"Federal Benefits for Veterans and Dependents" (VA Fact Sheet 1S-1)--
Free of Charge
Veterans Benefits Office
Veterans Administration
Washington, D.C. 20420

"More Education, More Opportunity"--
Free of Charge
U.S. Office of Education
Division of Student Financial Aid
Washington, D.C. 20202

"Need A Lift"--$ .50 per copy (pre-paid)
American Legion, Department S
P.O. Box 1055
Indianapolis, Indiana 46206

"Opportunities in Oceanography"--
$1.25 per copy
Smithsonian Press
Smithsonian Institution
Washington, D.C. 20560

"Scholarships for American Indian Youth"--Free of Charge
Bureau of Indian Affairs
Department of the Interior
Washington, D.C. 20240

"Financing a College Science Education"--$ .15 per copy
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

# *CURRICULA IN*

# *MARINE SCIENCE*

## ADELPHI UNIVERSITY
### GARDEN CITY, LONG ISLAND, NEW YORK

Adelphi University Institute of Marine Sciences has research and teaching facilities at Dowling College, Oakdale, Long Island, New York and at the main campus, Garden City, Long Island, New York.

The principal research facility is the Institute of Marine Science located on the Connetquot River, approximately one mile from Great South Bay. The physical facilities include seven laboratories, two walk-in cold rooms, a shop, and instrument and storage rooms. Teaching laboratories provided by Dowling College are available during the two summer sessions. The R/V ZOSTERA, a 34-foot twin engine cabin cruiser and the R/V GEORGE BERGAMINI, a 30-foot sea skiff, equipped with radio-telephone, fathometer, and generators, are utilized for estuarine research on the Great South Bay System. A Boston Whaler equipped with a 60 horsepower outboard motor and an aluminum skiff are available. Research equipment includes induction salinometers, submarine photometer, otter trawl net, seine nets, oxygen analyzers, specific-ion probes, pH meters, spectrophotometers, microscopes, photographic equipment, SCUBA masks, regulators and tanks, wet suits, incubators, centrifuges, and a seismic hammer with six channels.

The following degrees are offered:

1. M.S. in Biology specializing in Marine Biology.
   a. Thirty-three credits including eight for Thesis Research.
   b. Two biology laboratory courses.
   c. Presentation of a Master's thesis.
   d. A reading knowledge of French, German or Russian.
   e. A comprehensive examination, oral or written.
2. M.S. in Earth Science specializing in Marine Science and Environmental Science.
   a. Successful completion of 33 graduate credits as follows:

| | |
|---|---|
| Earth Science | 21-24 |
| Mathematics | 3-6 |
| Electives | 3-6 |

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| Bio 13 | Invertebrate Zoology | 4 |
| Bio 24 | Ecology | 4 |
| Bio 111 | Special Problems in Biology | arr. |
| Bio 112 | Special Problems in Biology | arr. |
| Bio 175 | Marine Biology Field Trip | 2 |
| ES 4 | Environmental Geology | 3 |
| Phys 150 | Pollution Problems and Environmental Science from a Physical Viewpoint | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| Bio 201 | Marine Biology | 4 |
| Bio 204 | Ecological Systems | 4 |
| Bio 211 | Selected Topics | 4 |
| Bio 213 | Marine Seminar-Contemporary Problems in Sources, Nature and Control of Pollutants | 2 |
| Bio 237 | Marine Botany | 4 |
| Bio 238 | Marine Ecology | 4 |
| Bio 239 | Marine Microbiology | 4 |
| Bio 287 | Special Research Problems | 2 |
| Bio 288 | Special Research Problems | 2 |
| Bio 293 | Thesis Research | 4 |
| Bio 294 | Thesis Research | 4 |
| ES 227 | Geochemistry | 3 |
| ES 235-238 | Special Topics in Earth Science | |
| | Environmental Monitoring (235) | 3 |
| | Environmental Conservation (237) | 3 |
| ES 254 | Principles of Oceanography | 3 |
| ES 261 | Marine Geology | 3 |
| ES 265 | Coastal Processes | 3 |
| ES 274 | Principles of Hydrology | 3 |
| ES 298 | Guided Research | 3 |
| ES 299 | Master's Thesis Research | 3 |
| ES 300 | Earth Science Seminar | 3 |

The instructional staff for the courses listed above consists of the following:

BIOLOGY

Brenowitz, A. Harry, Ed.D., Professor
Cassin, Joseph M., Ph.D., Assistant Professor
Churchill, A. Coolidge, Ph.D., Assistant Professor
Hair, Malcolm E., Ph.D., Assistant Professor

EARTH SCIENCE

Cok, Anthony, Ph.D., Assistant Professor
Sirkin, Leslie, Ph.D., Associate Professor

PHYSICS

Garrell, Martin, Ph.D., Assistant Professor

To obtain further information, address all inquiries directly to:

Dr. Manson van B. Jennings, Dean
Graduate School of Arts and Sciences
Adelphi University
Garden City, Long Island, New York
11530

## UNIVERSITY OF ALABAMA
### BAYOU LA BATRE, ALABAMA

The University of Alabama Marine Science Institute is supported jointly by the University of Alabama in Birmingham. Two units are operated by the Marine Science Institute on the Alabama coast with the main office located on the Tuscaloosa campus. The Point Aux Pins Laboratory and campus lies six miles west of Bayou La Batre, Alabama, the center of Alabama's shrimp industry. At Point Aux Pins is a renovated quartersboat housing the administrative unit, the research labs and a dormitory on the upper deck capable of housing 30 students during the summer term. A separate instructional building contains two large laboratory-lecture rooms (geology and ecology) and an office-library. Shop and maintenance functions are located in a building near the quartersboat. Facilities in the quartersboat include a physiology lab, pesticide monitoring unit, photography lab, microscopy lab, aquatics lab and biomedical lab. This building also contains the diving locker, library, laundromat, galley and mess hall. Dormitory space is coeducational. Specialized equipment includes a visible UV spectrophotometer, atomic absorption spectrophotometer, gas-liquid chromatography, thin-layer chromato-

graphy, electrophoresis and sieve-hydrometer, sediment analysis gear in the geology lab. The vessel maintenance facility located in Bayou La Batre operates three major boats. The R/V AQUARIUS is a 65-foot offshore-estuarine steel hulled research vessel equipped for general sampling. A 36-foot wooden bay trawler, the FIN, is rigged primarily for biological sampling and class work. The SEABIRD is a 23-foot fiberglass hulled deep-V boat with diesel inboard/outboard drive for high speed sample recovery and for the diving program.

Degrees in the various marine related sciences are earned at the two campuses in a particular degree granting department.* Undergraduate marine courses are also offered at the Institute to prepare students for graduate work in the marine environment or simply to add depth to their general background.

*A degree in Marine Sciences is being planned for the near future.

The following courses are offered by the Institute during the summer in conjunction with the above program:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| MS 101 | Experimental Marine Embryology | 6 |
| MS 103 | Invertebrate Marine Ecology | 6 |
| MS 110 | Fisheries Science | 6 |
| MS 115 | Coastal Ornithology | 6 |
| MS 116 | Physiology of Marine Invertebrates | 3 |
| MS 130 | Research on Special Topics | arr. |
| MS 150 | Seminar | 1 |
| MS 102 | Vertebrate Marine Ecology | 6 |
| MS 104 | Marine Geology | 6 |

All of the above courses may be taken at the graduate level (200) if the student is admitted to a graduate school and completes a related research project during the course.

The instructional staff for the courses listed above consists of the following:

Boschung, Herbert I., Ph.D., Professor of Biology (Tuscaloosa)
Brett, C. Everett, Ph.D., Interim Director; Associate Professor of Geology (Tuscaloosa)
Crozier, George F., Ph.D., Assistant Director; Assistant Professor of Anatomy (Birmingham)
Hand, George S., Ph.D., Assistant Professor of Anatomy (Birmingham)
Holliman, Dan C., Ph.D., Associate Professor of Biology (Birmingham-Southern College)
Rounsefell, George A., Ph.D., Professor of Biology (Tuscaloosa)
Williams, Louis G., Ph.D., Professor of Biology (Tuscaloosa)

To obtain further information, address all inquiries directly to:

Dr. C. Everett Brett, Interim Director
University of Alabama
Marine Science Institute
Box 1927
University, Alabama 35486

## UNIVERSITY OF ALASKA
COLLEGE, ALASKA

On the main University of Alaska campus at College, the Institute of Marine Science is currently housed within the Duckering Building. The Institute library employs a full-time librarian and contains over 5,000 volumes, together with a large reprint file relating principally to oceanography and ocean engineering. This latter collection is coded and computerized for rapid retrieval of specific information. In addition to this facility, the main University library and the specialized collections of other campus institutes and departments are readily available. The Institute also maintains an upgraded drafting and photographic unit.

The chemical oceanography section now has two specialized gas chromatographs for determining hydrocarbon pollutants in seawater. Within the same section, new equipment for work on trace inorganics in both freshwater and seawater has required the addition of specialized polarographic modules and relocation has made it possible for both the biology-ecology and geology sections to acquire new equipment. In addition to the stable isotope analysis equipment, facilities are now available for gas, pigment, nutrient, carbon, nitrogen, and elemental tracer analyses in the biological laboratories. The marine geology laboratory is equipped with standard size analysis apparatus, petrographic microscopes, atomic absorption spectrophotometer, and a pressure flow system for diagenetic experiments.

The Douglas Marine Station, located near Juneau, now consists of two buildings with facilities for research, instructing, administration, equipment fabrication, and storage. A total of 10,000 square feet of floor space includes laboratories for biology, chemistry, geochemistry, petrology, and sedimentology, with two general-purpose labs and a lecture room for summer field courses. Additional facilities available include a small library, darkroom, rock preparation lab, and a small walk-in cold storage unit for deep-sea sediment cores. Major research equipment recently added to the Marine Station includes a Perkin-Elmer 303 atomic absorption spectrophotometer and a Ziess Ultraphot microscope. The station's Mt. Jumbo Building serves as a 20-man dormitory and also houses a machine shop, a plastics fabrication bench, and a woodworking shop.

The Seward Marine Station, located in Seward, Alaska, now consists of a 14,000 square foot machine shop and six acres of dockside property with 150 feet of dock. Laboratory space suitable for research in biology, chemistry and geochemistry is also available. One of the principal missions of Seward Station is support of the R/V ACONA.

In cooperation with the U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, the Institute of Marine Science has constructed a field station on the shore of Izembek Lagoon, an embayment of the Bering Sea 15 miles from the village of Cold Bay. The station, consisting of two quonset huts originally built during the military occupation of the area 25 years ago, comprises living quarters and a laboratory. These facilities can accommodate 3 or 4 investigators plus technicians. The equipment includes the essentials for routine chemical and biological work plus some specialized instruments for physiological studies.

For work in the Arctic Ocean and on the northern coast of Alaska, facilities are

made available to the Institute by the Naval Arctic Research Laboratory at Point Barrow. The NARL provides all logistic support (including rig transportation) for work on the north coast and on the T-3 Ice Island. The Institute shares two hydro-huts with the physical oceanography group from the University of Washington.

The Institute operates the Research Vessel ACONA as its principal oceanographic platform. The R/V ACONA is an 85-foot steel vessel which carries a professional crew of six and a scientific party of nine. The ACONA is equipped with an oceanographic winch, a light hydrographic winch, two radars, three depth sounders, a precision depth recorder, three radio transceivers, loran, and other standard navigational equipment. The laboratory space requires most scientific equipment to be temporarily installed and removed each cruise. The ACONA has a speed of nine knots and an endurance of three weeks or 4500 miles.

The Institute also operates the 42-foot Motor Vessel MAYBESO--an eight-knot, wooden craft of basic fishing vessel design. The MAYBESO has a professional Captain and carries a four-man scientific party. The ship is equipped with a 400-meter hydrographic winch, two radio transceivers, and two depth sounders. Two 16-foot Boston Whalers and several miscellaneous skiffs are maintained at Douglas for daily use in the local area. Other vessels and aircraft are, on occasion, chartered for specific work required by Institute programs.

The purpose of the program in oceanography is to train oceanographers at the M.S. and Ph.D. level. The program is coordinated by an interdisciplinary committee of the University composed of selected staff members from the academic colleges and research institutes involved with ocean science.

The following degrees are offered:

1. M.S. Degree in Biological Oceanography. (Thesis required) Prerequisites--B.S. in the natural sciences, courses in calculus and physical chemistry. Minimum credit requirements--30 graduate credits (nine of which may be thesis credits). Course requirements--OCN 620, OCN 650, OCN 661, and OCN 613, and a minimum of nine credits of additional course work to be selected by the student's committee.

2. M.S. Degree in Chemical Oceanography. (Thesis required) Prerequisites--B.S. in the natural sciences, courses in calculus and physical chemistry. Minimum credit requirements--30 graduate credits (nine of which may be thesis). Course requirements--OCN 620, OCN 661, OCN 663, OCN 650, and OCN 613 or OCN 650 and a minimum of nine credits of additional course work to be selected by the student's committee.

3. M.S. Degree in Geological Oceanography. (Thesis required) Prerequisites--B.S. in the natural sciences, courses in calculus and physical chemistry. Minimum credit requirements--30 graduate credits (nine of which may be thesis credits). Course requirements--OCN 620, OCN 661, OCN 613, and OCN 650 or BIO 652, and a minimum of nine credits of additional course work to be selected by the student's committee.

4. M.S. Degree in Physical Oceanography. (Thesis required) Prerequisites--B.S. in the natural sciences, courses in calculus and physical chemistry. Minimum credit requirements--30 graduate credits (nine of which may be thesis credits). Course requirements--OCN 613, OCN 620, OCN 661, and OCN 650, and a minimum of nine credits of additional course work to be selected by the student's committee.

5. Ph.D. Degree. There are no fixed course requirements nor is an M.S. degree required to obtain the Ph.D. degree. The degree is awarded for proven ability and scholarly attainment, the exact program to be determined by the student's advisory committee. A candidate for the Ph.D. degree in Marine Science will be expected to have had course work at least equivalent to that of the M.S. curriculum.

The following courses are offered in conjunction with the above degrees:

| | | | |
|---|---|---|---|
| OCN | 613 | Marine Geology | 3 |
| OCN | 620 | Introduction to Physical Oceanography | 3 |
| OCN | 622 | Ocean Currents and Water Masses | 3 |
| OCN | 630 | Estuarine Dynamics | 3 |
| OCN | 650 | Introduction to Biological Oceanography | 3 |
| OCN | 661 | Chemical Oceanography I | 3 |
| OCN | 663 | Chemical Oceanography II | 3 |
| OCN | 690 | Colloquium | 3 |
| OCN | 691 | Seminar | 3 |
| OCN | 692 | Seminar | 3 |
| OCN | 693 | Special Topics | arr. |
| OCN | 694 | Special Topics | arr. |
| OCN | 697 | Thesis | arr. |
| OCN | 698 | Thesis | arr. |
| **BIOLOGY** | | | |
| Bio | 652 | Marine Ecology | 3 |
| **CHEMISTRY** | | | |
| Chem | 665 | Cellular Biochemistry | 3 |
| **GEOLOGY** | | | |
| Geo | 401 | Invertebrate Paleontology | 4 |
| Geo | 631 | Marine Geochemistry | 3 |
| **PHYSICS** | | | |
| Phys | 361 | General Geophysics | 3 |
| Phys | 362 | General Geophysics | 3 |
| Phys | 460 | Geophysical Prospecting | 3 |
| Phys | 465 | Meteorology | 3 |
| Phys | 621 | Classical Mechanics | 3 |
| Phys | 625 | Hydrodynamics | 3 |
| Phys | 665 | Dynamic Meteorology | 3 |
| **WILDLIFE MANAGEMENT** | | | |
| W.M. | 325 | Scientific Sampling | 3 |
| W.M. | 423 | Limnology | 3 |
| W.M. | 424 | Ecology of Fishes | 3 |
| W.M. | 426 | The Analysis of Linearized Models | 3 |
| W.M. | 624 | Problems in Fisheries Management | 2 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Allen, Mary Belle, Ph.D., Professor of Microbiology and Marine Algology
Barsdate, Robert J., Ph.D., Associate Professor; Limnology and Chemical



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Oceanography
Behlke, Charles E., Ph.D., Dean of College of Mathematics, Physical Sciences and Engineering; Professor of Engineering
Benson, Carl S., Ph.D., Professor of Geology and Geophysics
Berg, Eduard, Ph.D., Professor of Geophysics
Billaud, Vera A., Ph.D., Associate Professor of Marine Science; Limnology
Burrell, David C., Ph.D., Associate Professor of Marine Science; Geochemistry
Button, Don K., Ph.D., Associate Professor of Marine Science; Biochemistry
Forbes, Robert E., Ph.D., Professor of Geology; Igneous Petrology
Goering, John J., Ph.D., Professor of Marine Science; Biological Oceanography
Hood, Donald W., Ph.D., Director, Institute of Marine Science and Professor of Marine Science; Chemical Oceanography
Irving, Laurence, Ph.D., Advisory Scientific Director and Professor of Zoophysiology; Institute of Arctic Biology
Kinney, Patrick J., Ph.D., Associate Professor of Marine Science; Chemical Engineering
Matthews, J. Brian, Ph.D., Associate Professor of Marine Science; Physical Oceanography
Mcroy, Peter C., M.S., Assistant Professor; Biological Oceanography
Miller, Keith L., Ph.D., Assistant Professor of Zoophysiology
Morrow, James E., Ph.D., Professor of Zoology
Muench, Robin D., Ph.D., Assistant Professor; Physical Oceanography
Naidu, Angi S., Ph.D., Assistant Professor; Geological Oceanography
Nayudu, Y. R., Ph.D., Professor of Marine Science; Geological Oceanography
Osterkamp, Thomas E., Ph.D., Assistant Professor of Physics
Reeburgh, William S., Ph.D., Assistant Professor; Chemical Oceanography
Roberts, Thomas D., Ph.D., Associate Professor of Physics
Rosenberg, Donald H., M.S., Assistant Professor; Physical Oceanography
Royer, Thomas C., Ph.D., Assistant Professor; Physical Oceanography
Sharma, Ghanshyam D., Ph.D., Associate Professor; Marine Geology
Stone, David B., Ph.D., Associate Professor of Geophysics, Geophysical Institute
Van Hyning, Jack M., Ph.D., Associate Professor of Fisheries Biology
Wright, Frederick F., Ph.D., Assistant Professor; Marine Geology

To obtain further information, address all inquiries directly to:

Dr. Donald W. Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska 99701

## ALFRED UNIVERSITY
### ALFRED, NEW YORK

The College of Liberal Arts of the University offers courses in fields related to the marine sciences within the context of a program in Environmental Studies. The Science Departments are housed in modern buildings with adequate facilities for instruction and research. Faculty and students may also use the technical services and equipment of the College of Ceramics, a unit of The State University of New York and an integral part of Alfred University. These facilities, housed in Binns-Merrill Hall, include special laboratories for analyses by chemical, petrographic, spectroscopic, mass spectrometric, X-ray, and electron microscopic methods. A computer center, equipped with a Xerox Sigma 5 computer, is also available for use by students and faculty.

Field investigations are conducted on nearby Seneca Lake which has a maximum depth of over 600 feet and is generally ice free throughout the year. Access to the Great Lakes, continental shelf, and the coastal inland water-way is afforded by the canal system at the north end of the lake. The University maintains a lecture-laboratory building with an open docking facility on the west shore of Seneca Lake on leased property several miles north of Watkins Glen. Protected docking is available on the south shore of the lake.

Through its membership in a ten-college consortium (The College Center of The Finger Lakes) the University has access to three vessels for aquatic research and instruction. The 44-ton former buoy tender LAKE DIVER IV, and the 50-foot converted liberty vessel, SEARCHER I, are suitable for work in depths up to 600 feet. The 25-foot harbor launch, JOY I, is useful for near-shore and estuarine exploration. The vessels are equipped with adequate power sources, winches, fathometers, ship-to-shore communications, and navigation equipment - including radar on the SEARCHER I. Scientific equipment includes dredges, covers, plankton collecting devices, nansen bottles, temperature recording instruments, and onboard wet-chemical laboratories.

Opportunity for work directly in the marine environment may be afforded by arrangements for study and/or research with institutions located in coastal areas and engaged directly in oceanographic teaching and research. Additional experience can be acquired via a newly instituted experimental (non-credit) Marine Zoology course in tropical areas during the month of January.

The B.A. in Sciences and Social Sciences is offered. The Environmental Studies Program supplements these curricula via an inter-disciplinary orientation including aspects of the marine sciences.

In addition to the institutionally mandated hours and courses for the science and social science majors, the Program requires the election of recommended courses in Sociology, Geography, Aquatic Sciences and Ecology. A selection of optional electives appropriate to the development of a senior research project is also encouraged. A required senior inter-departmental seminar considers topics of broad interest and provides an opportunity for the exchange of ideas between students and faculty working on specific problems. Completion of the entire Environmental Studies Program is acknowledged by certification on the student's academic record. Graduate work is recommended for students motivated toward careers in aquatic or environmental studies.

The following courses are offered in con-

junction with the above program:

UNDERGRADUATE COURSES

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 311 | Invertebrate Zoology | 4 |
| 350 | Aquatic Techniques | 2 |
| 394 | Ecology | 4 |
| 430 | Problems in Ecology | 4 |
| 491 | Seminar | 1 |
| 450 | Research | HTBA |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 321 | Paleontology and Evolution | 3 |
| 322 | Paleontology and Evolution | 3 |
| 327 | Physical Geography | 3 |
| 332 | Oceanography | 3 |
| 450 | Independent Study | HTBA |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Barton, J.D., Jr., Ph.D., Professor of Biology
Finlay, Peter S., Ph.D., Professor of Biology
Rausch, James P., (Ph.D. candidate), Assistant Professor of Biology
Rough, Gaylord E., Ph.D., Chairman and Professor of Biology
Shivley, Carl E., Ph.D., Assistant Professor of Biology

DEPARTMENT OF CHEMISTRY

Klingensmith, Clarence W., Ph.D., Professor of Chemistry
Sands, Richard D., Ph.D., Chairman and Professor of Chemistry

DEPARTMENT OF GEOLOGY

Gerace, Donald T., M.S. in Ed., Assistant Professor of Environmental Studies
Sass, Daniel B., Ph.D., Chairman and Professor of Geology
Taylor, James A., Ph.D., Associate Professor of Geography

To obtain further information, address all inquiries directly to:

Mr. Nolan C. Cooper, Director
Office of Admissions
Alfred University - Crandall Hall
P.O. Box 765
Alfred, New York 14802

## UNIVERSITY OF ARIZONA
### TUCSON, ARIZONA

Marine science activities at the University of Arizona are focused primarily on the Gulf of California. An interdepartmental Marine Sciences Committee, headquartered in the Department of Biological Sciences, carries on an international, cooperative program with the Universidad de Sonora, Hermosillo, Mexico. The program has been in existence since 1958. The principal Mexican base of operations is the Puerto Peñasco Marine Laboratory built by the Universidad de Sonora near the small fishing town of Puerto Peñasco, Sonora at the northern end of the Gulf of California. The Laboratory is operated jointly by the two universities; it is located 219 road miles southwest of Tucson (paved highway) and is about one hour away by air. Its facilities (available throughout the year) include 650 square feet of indoor laboratory space and reference collections, shaded outdoor sea tables, and large, plastic-lined pools excavated in the beach sand (pattern changeable according to needs). The sea water system draws naturally filtered water from beach wells at a consistent temperature of 25°C ± 1°. The University of Arizona operates a nearby residence as a dormitory and classroom facility for visitors. Moderate use fees are charged.

About six kilometers of shoreline in front of the Marine Laboratory and the Classroom/Dormitory have been set aside as a preserve under the joint administration of the two universities, for teaching and research purposes (limited scientific collecting allowed). Tidal variations exceeding 20 feet provide exceptional exposure of rich biotas in a diversity of littoral environments within a short distance of the Marine Laboratory. Small boats are available, but no major seagoing vessels are maintained; charter of sportfishing boats and (in the off-season) commercial shrimp trawlers is possible in the town of Puerto Peñasco.

The following degrees are offered:

1. M.S. in Biology, Botany, or Zoology, Department of Biological Sciences. Students majoring in Marine Biology may elect to take the master's degree in either Biology, Botany, or Zoology. Intended candidates for the M.S. must present a minimum of about 32 hours of undergraduate preparation in biological sciences equivalent to the requirements for an undergraduate major in this department. They should have completed two years of chemistry (inorganic and organic), mathematics through beginning calculus, and a year of physics. Deficiencies in undergraduate preparation must be made up. An official record of the student's performance in the Graduate Record Examination (Aptitude and Advanced Test in Biology), a full transcript of undergraduate course work, and three letters of recommendation are required of all applicants. The student must complete 30 graduate credit units in an approved graduate study program. Both thesis and non-thesis M.S. programs are available.

2. Ph.D. in Biology, Botany, or Zoology, Department of Biological Sciences. Students majoring in Marine Biology may elect to take the doctorate degree in either Biology, Botany, or Zoology. Intended candidates for the Ph.D. must present undergraduate coursework as for the M.S. degree (above). Deficiencies in undergraduate preparation must be made up. GRE scores, transcripts, and letters of recommendation as described for the M.S. degree (above) are required of all applicants. In addition to the major, a suitable minor area must be selected, and the student must complete an approved, individually-planned graduate study program including course work in the minor field. An approved dissertation problem is required of all students, and each must (1) pass qualifying, preliminary and final oral examinations, and (2) demonstrate achieved proficiency in one foreign language.

Courses in the marine sciences and related fields are offered during the regular year at the main campus by the Department of Biological Sciences, Atmospheric Sciences, Geosicences, Hydrology and Water Resources

Program, and Agricultural Chemistry and Soils. The Department of Biological Sciences also offers both regular summer courses and special field research instruction at the Puerto Peñasco Marine Research Station.

UNDERGRADUATE COURSES
(may be taken for Graduate Credit with Dean's consent)

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 240 | Oceanography | 2 |
| 240L | Oceanography Laboratory | 2 |
| 242 | Marine Ecology | 5 |
| 245 | Aquatic Resource Biology | 2 |
| 245L | Aquatic Resource Biology Laboratory | 2 |
| 266 | Comparative Physiology | 4 |
| 276 | Marine Algae | 3 |
| 280 | Invertebrate Zoology | 4 |
| 282 | Ichthyology | 4 |
| 290 | Animal Behavior | 2 |
| 299 | Special Problems | 1-5 |
| 299b | Problems in Applied Marine Biology | 2 |

DEPARTMENT OF ATMOSPHERIC SCIENCES

| | | |
|---|---|---|
| 221 | Physical Climatology | 3 |
| 227 | Bioclimatology | 3 |

DEPARTMENT OF GEOSCIENCES

| | | |
|---|---|---|
| 214 | Sedimentary Environments | 3 |

HYDROLOGY AND WATER RESOURCES PROGRAM
(inter-departmental)

| | | |
|---|---|---|
| 281 | Physical Oceanology and Limnology for Hydrologists | 2 |

DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

| | | |
|---|---|---|
| 265 | Hydrochemistry | 3 |

GRADUATE COURSES

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 340 | Advanced Studies in Marine Biology | 2 |
| 400 | Research | 1-8 |
| 410 | Thesis | 1-8 |
| 420 | Dissertation | 1-9 |

The University also offers graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGICAL SCIENCES

Baldwin, Howard A., M.S., Research Associate
Barnard, J. Laurens, Ph.D., Research Associate and Curator of Crustecea, Smithsonian Institution Systematics and Biology of Amphipods
Brusca, Richard M., M.S., Research Associate and Resident Marine Biologist, Puerto Peñasco
Carlson, John S., Ph.D., Assistant Professor
Hendrickson, John R., Ph.D., Professor
Hoshaw, Robert W., Ph.D., Professor
Mead, Albert R., Ph.D., Professor
Miller, Walter B., Ph.D., Assistant Professor and Curator of Invertebrates
Pickens, Peter E., Ph.D., Associate Professor
Russell, Stephen M., Ph.D., Associate Professor and Curator of Birds
Thomson, Donald A., Ph.D., Associate Professor and Curator of Fishes
Ziebell, Charles D., M.S., Lecturer and Assistant Leader, Arizona Cooperative Fishery Unit

DEPARTMENT OF ATMOSPHERIC SCIENCES

Hastings, J. Rooney, Ph.D., Professor
Sellers, William D., Ph.D., Professor

DEPARTMENT OF GEOSCIENCES

Schreiber, Joseph F., Jr., Ph.D., Professor

HYDROLOGY AND WATER RESOURCES PROGRAM
(inter-departmental)

Simpson, Eugene S., Ph.D., Professor

DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

Dutt, Gordon R., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dr. J. R. Hendrickson
Coordinator, Marine Sciences
Department of Biological Sciences
The University of Arizona
Tucson, Arizona 85721

## BOSTON UNIVERSITY
### BOSTON, MASSACHUSETTS

The University offers a graduate program in marine biological sciences with components based in Woods Hole, Massachusetts, at the Marine Biological Laboratory, and in Boston at the New England Aquarium, Central Wharf, and the Charles River Campus. The Boston University Marine Program (BUMP) first offered courses in marine biology at Woods Hole during the academic year (September - May) in 1969-70. These courses now include marine invertebrate zoology, marine ecology, and environmental physiology, and are accompanied by seminars in related areas. Each course is given in an intensive six week unit. There are opportunities for research and for research training in marine problems throughout the academic year. BUMP has, for the purpose of in-shore field work, a 12-passenger Ford Club Wagon and a 13-foot Boston Whaler (trailer-borne). Qualified graduate students from other institutions may take any courses offered on a "leave of absence" basis from their home institutions with academic credit available for transfer from Boston University Graduate School. BUMP is complemented by the Systematics-Ecology Program (SEP) of the Marine Biological Laboratory in operation year round. Research supporting services available through cooperation with SEP of MBL include a 65-foot research vessel, R/V A.E.VERRILL, the George M. Gray Museum, a SCUBA diving

unit, and biophotographic unit.

The Geology Department participates with the Biology and Geography Departments in the Boston University Marine Program (BUMP) in cooperation with the Marine Biological Laboratory at Woods Hole, Massachusetts, and the New England Aquarium at Boston, Massachusetts. A cooperative program with the Department of Geology and Geophysics at nearby Boston College permits degree candidates to pursue courses in areas such as geophysics, regional geology, and structural geology.

The following degrees are offered by the University:

1. Ph.D. in Marine Biology. Graduate students in BUMP may be in residence at the Marine Biological Laboratory, Woods Hole, for part of their program. The courses to be taken on campus in Boston are determined in consultation with the major professor. Research may be carried out either at MBL or at the New England Aquarium, as well as on the Boston campus.

In general an A.M. degree or equivalent is prerequisite to admission as a Ph.D. candidate, but exceptionally well qualified students may by-pass the A.M. and be admitted directly to the Ph.D. program. With an A.M. each student must take eight one semester graduate-level courses; with the by-pass sixteen such courses are required.

A reading knowledge of one modern foreign language (two languages at the discretion of the major professor) is required. In addition, special training in the use of computers or other instrumentation may be required.

Before beginning work on his dissertation each student takes a qualifying examination to demonstrate mastery of basic subjects in his special field. After the dissertation has been completed the student takes a final oral examination in which he defends his dissertation as a worthy contribution to its field and demonstrates a mastery of the field of specialization related to it.

2. A.M. Students are expected to complete eight one semester graduate-level courses. A reading knowledge of one foreign language is required. Each student must prepare a thesis based on reseach. Usually A.M. students will take most of their course work on campus in Boston.

3. B.A. in Geology. Requirements include seven courses in Geology, including Mineralogy, Paleontology, Areal Geology, and Senior Research: a minimum of five one-semester courses in Astronomy, Biology, Chemistry, Geography, Mathematics and Physics, including two in Mathematics and two in Physics.

4. M.A. in Geology. Prerequisites: (can be made up without credit) three semester courses in Geology, one year of college-level courses in each of Chemistry, Physics, and Calculus. Statistics may be substituted for the second semester calculus. Requirements: One to four of the eight courses required shall be taken in related fields in other departments; a research paper; a minimum of ten courses in geology at both the undergraduate and graduate levels, including a course in areal geology; one foreign language; pass oral comprehensive examination in Geology.

5. Ph.D. in Geology. Normally a candidate shall fulfill all requirements for M.A. degree in Geology including the oral examination which must be taken at Boston University. A candidate of excentional promise may be admitted directly from the baccalaureate. Requirements: Of 16 minimum required courses beyond the bachelor's degree, a minimum of two to a maximum of six shall be at the graduate level in related fields in other departments; four to eight courses shall be in research; a minimum of 16 courses in Geology in both undergraduate and graduate work, including an areal geology course; pass examinations in two areas of specialization, at least one to be conducted orally; two foreign languages, however, a candidate may substitute knowledge of computer programming or appropriate mathematics for the second language requirement; a dissertation; pass final oral examination.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| BI 303 | Invertebrate Zoology | 4 |
| BI 412 | Parasitology | 4 |
| BI 424 | Marine Biology | 2 |
| BI 441 | Marine Botany | 4 |
| BI 461 | Ecology | 4 |
| BI 462 | Ecology | 4 |
| BI 711 | Comparative Physiology | 4 |
| BI 725 | Ichthyology | 4 |
| BI 727* | Marine Invertebrate Zoology | 6 |
| BI 728 | Fishery Biology | 4 |
| BI 729* | Marine Ecology | 6 |
| BI 732* | Environmental Physiology | 4 |
| BI 744 | Marine and Soil Bacteriology | 4 |
| BI 811* | Seminar in Marine Biology | 2 |
| BI 813* | Seminar in Marine Biology | 2 |
| BI 812* | Seminar in Marine Biology | 2 |
| BI 814* | Seminar in Marine Biology | 2 |
| BI 935* | Research in Marine Biology | 3 |
| BI 937* | Research in Marine Biology | 3 |
| BI 936* | Research in Marine Biology | 3 |
| BI 938* | Research in Marine Biology | 3 |

DEPARTMENT OF GEOGRAPHY

| | | |
|---|---|---|
| GG 336 | Conservation of Natural Resources | 4 |
| GG 341 | Oceanography | 4 |
| GG 304 | Seminar in Meteorology | 4 |

DEPARTMENT OF GEOLOGY

GRADUATE COURSES OPEN TO UNDERGRADUATES

| | | |
|---|---|---|
| GL 403 | Marine Geology | 4 |
| GL 404 | Principles of Sedimentation and Stratigraphy | 4 |
| GL 411 | Hydrogeology | 4 |
| GL 412 | Hydrogeology | 4 |
| GL 432 | Invertebrate Paleontology (Paleozoology) | 4 |
| GL 452 | Principles of Seismology | 4 |

GRADUATE COURSES

| | | |
|---|---|---|
| GL 714 | Laboratory and Field Hydrology | 4 |
| GL 732 | Invertebrate and Micropaleontology | 4 |
| GL 733 | Principles of Paleoecology | 4 |
| GL 751 | Geotectonics | 4 |
| GL 752 | Geotectonics | 4 |

*These courses are given at Woods Hole. Courses numbered 700 or above are graduate-level courses.

Other courses in these departments and in Chemistry, Mathematics, Engineering, and Medical Sciences may be directly applicable, depending upon the student's special field.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Belamarich, Frank A., Ph.D., Associate Professor of Biology
Booke, Henry E., Ph.D., Assistant Professor of Biology
Carriker, Melbourne R., Ph.D., Adjunct Professor of Biology
Fulton, George P., Ph.D., Chairman and Shields Warren Professor of Biology
Golubic, Stefan, Ph.D., Assistant Professor of Biology
Humes, Arthur G., Ph.D., Professor of Biology and Acting Director of BUMP
McLeod, Guy C., M.S., M.A., Lecturer in Biology
Read, Kenneth R.H., Ph.D., Associate Professor of Biology
Tiffney, Wesley N., Ph.D., Professor of Biology
Valiela, Ivan, Ph.D., Assistant Professor of Biology

DEPARTMENT OF GEOGRAPHY

Batchelder, Robert B., Ph.D., Professor of Geography
Lewis, George K., Ph.D., Chairman and Professor of Geography

DEPARTMENT OF GEOLOGY

Brownlow, Arthur H., Ph.D., Associate Professor of Geology
Caldwell, Dabney W., Ph.D., Associate Professor of Geology
Cameron, Barry, Ph.D., Assistant Professor of Geology
Wolfe, C. Wroe, Ph.D., Professor of Geology

The following members of the faculty of the Department of Geology and Geophysics at Boston College are currently participating in the Boston University-Boston College Interinstitutional Geology Program:

Bombolakis, Emanuel G., Ph.D., Associate Professor
Brooks, Edward M., D.Sc., Professor
Skehan, James W., S.J., Professor

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Boston University
705 Commonwealth Avenue
Boston, Massachusetts 02215

Professor Mohamed A. Gheith, Chairman
Department of Geology
Boston University
725 Commonwealth Avenue
Boston, Massachusetts 02215

## UNIVERSITY OF BRIDGEPORT
### BRIDGEPORT, CONNECTICUT

The University offers courses in marine science within the framework of the Biology Department and utilizes the laboratories of that discipline with the exception of a single laboratory devoted to primarily estuarine studies. Specialized facilities of the U.S. Shellfish laboratory at Milford, Connecticut are available on an informal basis. The University maintains a single shallow draft vessel, the BLITCH, for estuarine and riverine survey work.

The University offers the M.S. degree in Biology; a student may elect to pursue a marine science direction within its course structure. A thesis project may be done in estuarine studies or in the general area of marine populations.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| Biol 315 | Invertebrate Zoology | 3 |
| Biol 316 | Invertebrate Zoology | 3 |
| Biol 380 | Oceanography | 3 |
| Biol 516 | Marine Ecology | 4 |
| Biol 518 | Limnology | 4 |
| Biol 519 | Estuarine Biology | 4 |
| Biol 580 | Seminar: Marine Science | 3 |

The instructional staff for the courses listed above consists of the following:

James, Hugo A., Ph.D., Associate Professor of Biology (Invertebrate Zoology)
Poluhowich, John J., Ph.D., Assistant Professor of Biology (Estuarine Biology)
Singletary, Robert, Ph.D., Assistant Professor of Biology (Oceanography)
Sommers, Michael E., Ph.D., Chairman and Associate Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Michael E. Sommers, Chairman
Department of Biology
University of Bridgeport
Bridgeport, Connecticut 06602

## BRIDGEWATER STATE COLLEGE
### BRIDGEWATER, MASSACHUSETTS

Bridgewater State College opened a new Science Building in 1964 which houses the Division of Natural Sciences and Mathematics, composed of the Departments of Biological Sciences, Chemistry, Earth Sciences, Physics, and Mathematics. There are 12 classrooms, 26 teaching laboratories, 37 faculty offices, 4 research areas, and a 265-seat lecture hall. The Department of Biological Sciences also has a bio-assay laboratory, walk-in refrigerator, deep-freeze, and incubator rooms. In addition, a greenhouse and science gardens are on the campus, and the College has access to a wildlife refuge with woodlands, ponds, and marsh one-half mile from the campus.

Bridgewater State College is located within an hour's drive of many coastal sites, including the Buzzards Bay and Cape Cod Bay areas. At the present time an arrangement exists with the Marine Biological Laboratories at Woods Hole Oceanographic Institute with a course on Intertidal Biology being taught in the facilities of both institutions.

The College offers the following degrees:

1. Bachelor of Arts with majors in one of the following disciplines: Biology, Chemistry, Earth Sciences, or Physics, under the respective departments, with participation in an inter-departmental Oceanography Program.

Programs in oceanography are offered as a cooperative effort of all departments within the Division of Natural Sciences and

Mathematics. These programs are designed to prepare students for graduate school or professional employment in oceanography. Courses in related areas may be selected by the student with the approval of his major advisor. A student interested in oceanography consults both his major advisor and a member of the Advisory Committee on Oceanography during his freshman year.

2. Master of Arts in Biology (Department of Biological Sciences). Programs are individually developed and may include studies of the natural marine habitats of the Eastern Atlantic Coast. Research opportunities in marine biology are available. The Cape Cod Bay and Buzzards Bay areas are within an hour's drive of the campus, and work is done at the Woods Hole Oceanographic Institute.

3. Master of Arts in Chemistry (Department of Chemistry). Each student is required to complete at least thirty hours of graduate level courses. This may include up to twelve hours of research in areas related to the marine sciences.

The following courses are offered in conjunction with the above programs. Courses in the 500 series are graduate only.

UNDERGRADUATE-GRADUATE COURSES

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| BI 392 | Problems in Biology | * |
| BI 410 | Marine Biology | 3 |
| BI 502 | Thesis | * |
| BI 521 | Intertidal Biology | 3 |
| BI 522 | Intertidal Biology | 3 |

DEPARTMENT OF CHEMISTRY

| | | |
|---|---|---|
| CH 390 | Research Problems in Chemistry | * |
| CH 450 | Instrumental Analysis | 3 |
| CH 461 | General Biochemistry | 4 |
| CH 462 | General Biochemistry | 4 |
| CH 502 | Thesis | * |

DEPARTMENT OF EARTH SCIENCES

| | | |
|---|---|---|
| ES 305 | Introduction to Oceanography | 3 |
| ES 306 | Introduction to Oceanography | 3 |
| ES 472 | Research in Earth Sciences | * |

* Time and credit to be arranged.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGICAL SCIENCES

Cirino, Elizabeth F., Ph.D., Professor of Zoology
Jahoda, John C., Ph.D., Assistant Professor of Zoology
Mish, Lawrence B., Ph.D., Professor of Botany
Wall, William J., Jr., Ph.D., Professor of Zoology

DEPARTMENT OF CHEMISTRY

Marganian, Vahe M., Ph.D., Assistant Professor of Chemistry

DEPARTMENT OF EARTH SCIENCES

Boutilier, Robert F., Ph.D., Associate Professor of Earth Science
Enright, Richard, Ph.D., Assistant Professor of Earth Science

WOODS HOLE OCEANOGRAPHIC INSTITUTE

Chase, Joseph, Ph.D., Visiting Lecturer in Oceanography
Dunston, William, Ph.D., Visiting Lecturer in Oceanography

To obtain further information, address all inquiries directly to:

Dr. Frank J. Hilferty
Dean of the Graduate School
Bridgewater State College
Bridgewater, Massachusetts 02324

## CALIFORNIA INSTITUTE OF TECHNOLOGY
### PASADENA, CALIFORNIA

The Institute, through its Division of Biology, maintains the Kerckhoff Marine Laboratory at Corona del Mar. This Laboratory houses facilities for teaching and research in marine zoology, embryology, biochemical physiology and ecology. It has a ship, boats and tackle for collecting, and running seawater aquaria.

The Institute does not offer degrees in marine sciences as such: students interested in relevant areas may obtain a B.S. in Biology, a Ph.D. in one of the Biology disciplines, a M.S. or a Ph.D. in Environmental Engineering Science.

The following courses are offered in conjunction with the above programs:

DIVISION OF BIOLOGY

| | | |
|---|---|---|
| Bi 101 | Invertebrate Biology | 12 |
| Bi 106 | Introductory Developmental Biology of Animals | 12 |
| Bi 220 | Developmental Biology of Animals | 6 |
| Env 144 | Ecology | 6 |
| Env 145 | Environmental Biology | 10 |

The Institute also offers undergraduate and graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DIVISION OF BIOLOGY

Brokaw, Charles J., Ph.D., Professor of Biology

DIVISION OF ENGINEERING AND APPLIED SCIENCE

North, Wheeler J., Ph.D., Professor of Environmental Science

To obtain further information, address all inquiries directly to:

Dr. R.L. Simsheimer, Chairman
Division of Biology
California Institute of Technology
Pasadena, Calironia 91109

## CALIFORNIA STATE COLLEGE, LONG BEACH
### LONG BEACH, CALIFORNIA

The Department of Biology occupies facilities in three science buildings and has

an electron microscope, a sea water system, greenhouses and research and teaching collections of vertebrates and invertebrates. Courses are offered in several areas of experimental biology. Because the campus is near the ocean, mountains, and deserts, the department is able to offer a number of field and laboratory courses in marine biology, ecology, entomology and vertebrate zoology.

The degree of B.S. in Marine Biology is offered. The requirements for this degree are as follows:

Lower Division: Botany 212, Chemistry 111A-B, Mathematics 120, Physics 100A-B, Zoology 210A-B.

Upper Division: Biology 311, 416, Anatomy and Physiology 340 or 440, Botany 320, Zoology 310, 320, English 317, Chemistry 327, Geology 462; 6 units of electives in marine biology and related areas selected from Zoology 311, 312, 351, 420, 450, and C.E. 468; plus six units of electives from the following: Biology 350, 360, 361, 430, 461; Botany 330, 331, 440; Zoology 331, 332, 350; and 12 units of general electives.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| Ant 340 | Comparative Animal Physiology | 3 |
| Ant 440 | General and Cellular Physiology | 4 |
| Bio 311 | Genetics | 4 |
| Bio 416 | Marine Biology | 3 |
| Bot 320 | Algae | 3 |
| Bot 330 | Plant Anatomy | 3 |
| Bot 331 | Plant Morphology | 4 |
| Bot 440 | Plant Physiology | 4 |
| CE 468 | Marine Pollution Control | 3 |
| Chm 327 | Organic Chemistry | 3 |
| Geo 462 | Elements of Physical and Chemical Oceanography | 3 |
| Geo 464 | Geological Oceanography | 3 |
| Zoo 310 | Invertebrate Zoology | 4 |
| Zoo 320 | Ichthyology | 3 |
| Zoo 311 | Biology of the Protozoa | 4 |
| Zoo 312 | General Animal Parasitology | 4 |
| Zoo 351 | Animal Behavior | 4 |
| Zoo 420 | Invertebrate Systematics | 3 |
| Zoo 450 | Ecology of Fishes | 3 |
| Zoo 331 | Vertebrate Embryology | 4 |
| Zoo 332 | Histology | 3 |
| Zoo 350 | Dynamics of Animal Populations | 3 |

The instructional staff for the courses listed above consists of the following:

BIOLOGY

Dailey, Murray D., Ph.D., Associate Professor, Biology
Ho, Ju-Shey, Ph.D., Assistant Professor, Biology
Lane, Edwin D., Ph.D., Assistant Professor Biology
Nelson, Donald R., Ph.D., Associate Professor, Biology
Reish, Donald J., Ph.D., Professor, Biology
Renshaw, R. Ward, M.A., Assistant Professor, Biology
Widdowson, Thomas B., Ph.D., Associate Professor, Biology

GEOLOGY

Chan, Kwan M., Ph.D., Associate Professor, Geology

To obtain further information, address all inquiries directly to:

Dr. Carpenter, Chairman,
Biology Department
6101 E. Seventh Street
Long Beach, California 90801

## CALIFORNIA STATE POLYTECHNIC COLLEGE
### SAN LUIS OBISPO, CALIFORNIA

A newly completed Science North building houses a recirculating sea water system with water tables in a marine teaching laboratory, student research laboratory, and faculty office-preparation room complex. A boat and gear storage building is adjacent, housing a sea water storage tank, a 16-foot outboard dory and trailer, overhead crane, net drying racks, and gear storage lockers. Four 12-foot skiffs are available as well for use on Morro Bay and Port San Luis. Fishing boats at Morro Bay and Port San Luis are available on charter for open water work.

A variety of well-equipped laboratories are available in the Agricultural Engineering area for class and student use for the Maricultural Engineering program. A wide range of commercial marine industries are in the proximity including Morro Bay, Port San Luis, Avila Bay, etc.

Facilities are available at the campus Computer Center for analysis of data.

The following degrees are offered.*

1. Bachelor of Science in Biological Sciences. A major concentration in Marine Biology. (Department of Biological Sciences)
2. Master of Science in Biological Sciences. (Department of Biological Sciences)

*A B.S. in Agricultural Engineering with major concentration in Maricultural Engineering is proposed for 1971-72.

The following courses are offered in conjunction with the above programs. Credits are in quarter units.

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| Bio 328 | Marine Biology | 4 |
| Bio 437 | Marine Resources | 4 |
| Bact 435 | Marine Microbiology | 4 |
| Bot 337 | Algology | 4 |
| Zoo 322 | Biology of Fishes | 4 |
| Zoo 336 | Invertebrate Zoology | 4 |

DEPARTMENT OF PHYSICS

| | | |
|---|---|---|
| Geo 321 | Marine Geology | 4 |

DEPARTMENT OF AGRICULTURAL ENGINEERING

| | | |
|---|---|---|
| MarE 222 | Survey of Maricultural Engineering | 4 |
| MarE 233 | Marine Surveying and Topography | 4 |
| MarE 243 | Maricultural Engineering Laboratory | 2 |

SCHOOL OF ENGINEERING AND TECHNOLOGY

| | | |
|---|---|---|
| Engr 270 | Introduction to Ocean Engineering | 3 |

The instructional staff for the courses listed above consists of the following:

BIOLOGICAL SCIENCES

Clogston, Fred L., Ph.D., Professor of Biological Sciences: Marine Biology
Fierstine, Harry L., Ph.D., Associate Professor of Biological Sciences: Biology of Fishes
Krejsa, Richard J., Ph.D., Assistant Professor of Biological Sciences: Biology of Fishes
Lazarus, Alfred S., Ph.D., Associate Professor of Biological Sciences: Marine Microbiology
Montgomery, David H., M.S., Associate Professor of Biological Sciences: Invertebrate Zoology
Richards, Thomas L., Ph.D., Assistant Professor of Biological Sciences: Marine Resources
Sparling, Shirley R., Ph.D., Associate Professor of Biological Sciences: Algology

PHYSICAL SCIENCES

Balthaser, Lawrence H., Ph.D., Assistant Professor of Physics: Marine Geology

MARICULTURAL ENGINEERING

Carnegie, Edgar J., M. Engineering, Associate Professor of Agricultural Engineering
Lamouria, Lloyd H., M.S., Professor and Head of Agricultural Engineering
Strohman, Rollin D., Ph.D., Assistant Professor of Agricultural Engineering
Waelti, Henry, Ph.D., Associate Professor of Agricultural Engineering

ENGINEERING

Bruckart, William, M.S., Assistant Professor of Engineering
Carlston, Richard C., Ph.D., Associate Professor of Engineering

To obtain further information, address all inquiries directly to:

Department Head, Biological Sciences Department
School of Science and Mathematics
California State Polytechnic College
San Luis Obispo, California 93401

Department Head, Agricultural Engineering Department
School of Agriculture and Natural Resources
California State Polytechnic College
San Luis Obispo, California 93401

## BODEGA MARINE LABORATORY
UNIVERSITY OF CALIFORNIA
BODEGA BAY, CALIFORNIA

The Bodega Marine Laboratory is a research and teaching facility of the University of California. The Laboratory is situated on a 326-acre biological refuge located on the outer coast of Bodega Head; the property includes more than a mile of rocky shoreline, short stretches of sandy beach, and mixed mud and sand flats in Bodega Harbor. The laboratory building houses 25 modern research laboratories and 2 teaching laboratories. Equipment and facilities are available for work in biochemistry, physiology, developmental biology, microbiology, ecology, botany, zoology, and marine geology. The laboratory is provided with running sea water which is pumped directly from the ocean; there is a large aquarium room which contains numerous aquaria and tanks which range in size up to a capacity of 1000 gallons. A 31-foot diesel powered cruiser and a 22-foot bartender are available for work in the open sea; other, smaller boats are available for work in the harbor.

The degrees of Master of Arts and Doctor of Philosophy in Botany, Geology and Zoology are offered by the Departments of Botany, Geology and Zoology of the Berkeley and Davis Campuses for research carried out at the Bodega Marine Laboratory. Courses at the Laboratory are credited toward degree work on these and other campuses of the University of California.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE

| | | |
|---|---|---|
| Bot 104 | Marine Botany | 8 |
| Geol 107 | Paleoecology | 5 |
| Geol 119 | Marine Geology and Paleoecology of the Continental Shelf | 8 |
| Zool 114 | Invertebrate Physiological Ecology | 5 |
| Zool 157 | Natural History of Marine Invertebrates | 8 |
| Zool 199 | Independent Study | 2-3 |
| Geol 198 | Directed Study | 2-3 |
| Interdepartmental Studies 100 | Problems in Marine Biology | 15 |

GRADUATE

| | | |
|---|---|---|
| Geol 219 | Special Studies in Marine Geology and Paleoecology | 6 |
| Zool 229 | Seminar in Marine Biology | 2 |
| Zool 257 | Advanced Marine Invertebrate Zoology | 5 |

The instructional staff for the courses listed above consists of the following:

BOTANY DEPARTMENT, U.C. BERKELEY

West, John, Ph.D., Associate Professor of Botany, Marine Botany

GEOLOGY DEPARTMENT, U.C. DAVIS

Chipping, David, Ph.D., Assistant Professor of Geology, Marine Geology
Lipps, Jere, Ph.D., Assistant Professor of Geology, Marine Geology and Paleoecology
Valentine, James, Ph.D., Associate Professor Geology, Marine Geology and Paleoecology

ZOOLOGY DEPARTMENT, U.C. BERKELEY

Ghiselin, Michael, Ph.D., Assistant Professor of Zoology, Invertebrate Zoology
Hand, Cadet, Ph.D., Professor of Zoology, Invertebrate Zoology
Smith, Ralph, Ph.D., Professor of Zoology, Invertebrate Zoology

ZOOLOGY DEPARTMENT, U.C. DAVIS

Hamner, William, Ph.D., Assistant Professor of Zoology, Ecology

To obtain further information, address all inquiries directly to:

Dr. Cadet Hand, Director
Bodega Marine Laboratory
P.O. Box 247
Bodega Bay, California 94923

## UNIVERSITY OF CALIFORNIA, DAVIS
### DAVIS, CALIFORNIA

The marine sciences program on the Davis campus provides instruction and research opportunities in geological and biological oceanography. This program is offered in the Departments of Geology and Zoology, and the Institute of Ecology. Each of these instructional units provides modern well-equipped laboratory, instrumental, and shop facilities, including transmission and scanning electron microscopes, an electron microprobe, controlled environment rooms, sea water systems, etc. The Zoology Department and Institute of Ecology have recently moved into new buildings, and the Geology Department will move into a new building in 1971.

In addition to the facilities on the Davis campus, the marine sciences program is supported by the Bodega Marine Laboratory, Bodega Bay, California, which is described earlier in this section.

The following degrees are offered in the basic sciences:

1. Department of Geology: B.A., B.S., M.S., Ph.D. in Geology with specialization in marine science.
2. Department of Zoology: B.A., B.S., M.A., Ph.D. in Zoology.
3. Ecology Graduate Group: M.S., Ph.D. in Ecology with specialization in marine science.
4. Biochemistry and Biophysics Department: M.S., Ph.D. in Biochemistry.

The Departments of Geology and Zoology, and the Institute of Ecology offer advanced degrees with thesis research in marine geology, ecology, paleoecology, or sedimentary petrology. An integrated, full-time program will be offered during the regular school year by the Departments of Geology and Zoology. A special curriculum in "Animal evolution in marine ecosystems" will be provided for advanced undergraduates and graduates by the Geology and Zoology Departments during the spring quarters.

The following courses are offered in conjunction with the above programs:

ECOLOGY

| | | |
|---|---|---|
| 201A | Ecological Theory | 3 |
| 201B | Analysis of a Selected Ecosystem | 3 |
| 201C | The Changing Biosphere | 3 |
| 390 | Seminar in Ecology | 1 |

GEOLOGY

| | | |
|---|---|---|
| 105 | Structural Geology | 4 |
| 107 | Paleobiology | 5 |
| 111A | Paleobiology of Invertebrata | 4 |
| 111B | Paleobiology of Protista | 4 |
| S119 | Marine Geology and Paleobiology | 9 |
| 126 | Sedimentation | 4 |
| 153 | Studies in Geomorphology | 3 |
| 190 | Seminar in Geology | 1 |
| 198 | Directed Group Study | 1-5 |
| 199 | Special Study for Advanced Undergraduates | 1-4 |
| 213 | Geomorphology | 3 |
| 216 | Tectonics | 3 |
| S219 | Research in Marine Geology and Paleobiology | 6-9 |
| 257 | Sedimentary Petrology: Terrigenous Rocks | 4 |
| 258 | Sedimentary Petrology: Carbonate Rocks | 4 |
| 260 | Paleontology | 3 |
| 261 | Paleocoenology | 3 |
| 262 | Paleosystematics | 3 |
| 263 | Functional Morphology of Fossil Invertebrates | 4 |
| 290 | Seminar in Geology | 1 |
| 298 | Group Study | 2 |
| 299 | Research | 1-6 |

ZOOLOGY

| | | |
|---|---|---|
| 112 | Invertebrate Zoology | 5 |
| 114 | Invertebrate Physiological Ecology | 5 |
| 116 | Principles of Animal Resource Management | 5 |
| 125 | Animal Ecology | 3 |
| 125L | Field Ecology | 3 |
| 140 | Limnology | 4 |
| 140L | Limnology Laboratory | 3 |
| 142 | Invertebrate Physiology | 4 |
| 142L | Invertebrate Physiology Laboratory | 3 |
| 144 | Oceanography | 4 |
| 147 | Zoogeography | 4 |
| 148 | Animal Phylogeny and Evolution | 5 |
| 160 | Invertebrate Neurophysiology | 5 |
| 197 | Senior Colloquium in Zoology | 2 |
| 199 | Special Study for Advanced Undergraduates | 1-5 |
| 202 | Biomathematics | 6 |
| 222 | Mathematical Models of Ecosystems | 4 |
| 223 | Seminar in Fisheries Management | 4 |
| 293 | Seminar in Invertebrate Zoology | 2 |
| 294 | Seminar in Animal Ecology | 3 |
| 295 | Seminar in Limnology | 3 |
| 297 | Seminar in Systematic Zoology and Evolution | 2 |
| 298 | Group Study | 1-5 |
| 299 | Research | 1-9 |

The University also offers an undergraduate program in Wildlife and Fisheries Biology and graduate programs in Food Science and Nutrition which are described in the Fisheries section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOLOGY

Chipping, Davis H., Ph.D., Assistant Professor
Cowen, Richard, Ph.D., Assistant Professor
Higgins, Charles G., Ph.D., Professor
Lipps, Jere H., Ph.D., Associate Professor
Moores, Eldridge M., Ph.D., Associate Professor
Valentine, James W., Ph.D., Professor

DEPARTMENT OF ZOOLOGY

Goldman, Charles R., Ph.D., Professor
Hamner, William M., III., Ph.D., Assistant Professor
Kammer, Ann E., Ph.D., Assistant Professor
Miller, Milton A., Ph.D., Professor
Rudd, Robert L., Ph.D., Associate

Professor
Salt, George W., Ph.D., Associate Professor
Watt, Kenneth E. F., Ph.D., Professor

To obtain further information, address all inquiries directly to:

GEOLOGY

Graduate Advisor
Department of Geology
University of California
Davis, California 95616

ECOLOGY

Graduate Advisor
Ecology Graduate Group
University of California
Davis, California 95616

ZOOLOGY

Graduate Advisor
Department of Zoology
University of California
Davis, California 95616

## CHAPMAN COLLEGE
### ORANGE, CALIFORNIA

Chapman College offers marine science courses on its Main Campus in Orange, California, and aboard its World Campus Afloat, an ocean-going passenger liner equipped to conduct classes for as many as 500 students enrolled in a semester-at-sea. The College was founded in 1861, and the Main Campus was opened in 1954 at the present site. A new science building was completed at the Main Campus in 1970 and includes facilities for the geology, chemistry, physics, and biology departments. The Science Division now has computer capability through General Electric Time-sharing Service, and in July, 1971, a N.C.R. Century 100 digital computer will be installed. Analytical equipment includes coulometers, spectrophotometers, and potentiometric instruments. The S.S. RYNDAM, a 15,000-ton vessel, 500-feet in length, presently serves as the shipboard campus. The ship program, which includes some of the marine science courses, as well as many other academic courses, is available to Chapman College students and to qualified students from other colleges and universities on a transfer basis.

The B.A. in Geology, B.S. in Biology, and B.A. in Biology are offered by the College. Chapman College does not offer an undergraduate degree in the marine sciences. A student wishing to pursue a career in oceanography should select either geology or biology for an undergraduate major and concentrate his graduate studies in the marine sciences.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 5 | Introduction to Oceanography | 3 |
| 108 | Marine Geology | 3 |
| 118 | Oceanographic Techniques | 2 |
| 170 | Methods of Investigation in Marine Science | 3 |

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 140 | Marine Biology | 3 |
| 170 | Research in Marine Biology | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOLOGY

Wimberley, Stanley, Ph.D., Associate Professor of Geology, Marine Geology, Physical Oceanography

DEPARTMENT OF BIOLOGY

Westervelt, Clinton A., Ph.D., Associate Professor of Biology, Marine Biology

DEPARTMENT OF PHYSICS

Yules, John A., M.S., Instructor in Physics, Physical Oceanography

To obtain further information, address all inquiries directly to:

Chairman, Division of Natural Science
Chapman College
Orange, California 92666

## UNIVERSITY OF CHICAGO
### CHICAGO, ILLIONIS

The Marine Sciences Program at the University of Chicago is within the Department of the Geophysical Sciences, located in the Henry Hinds Laboratory for the Geophysical Sciences. The central core of the building consists almost entirely of research laboratories and associated shop facilities. Among these are several wave tank laboratories which include wave tanks up to 80 feet long used for impulse wave and ocean wave studies, random wave and interaction studies, and internal wave investigations. Other facilities include a flume, wind tunnel, paleoecology laboratory, sedimentology laboratory, geochemistry laboratories, an electron microprobe, and x-ray diffraction equipment. The Hydrodynamics Laboratory occupies the subbasement. The University Computing Center is close by. Field facilities are available through cooperation with the Woods Hole Oceanographic Institution and the Pacific Marine Station of the University of the Pacific.

Degrees are not offered specifically in the Marine Sciences or Oceanography. The M.S. and Ph.D. degrees in the Geophysical Sciences are offered with specialization in the areas included within the Marine Sciences.

1. Master of Science (Geophysical Sciences). The requirements for this degree are:

a. A program of study approved by the Departmental Counsellor, normally consisting of nine graduate courses: at least three basic science courses, at least three geophysical sciences courses, and at least one research course. Courses in basic science may be taken in or outside the department.

b. An average grade of not lower than B and no grade lower than C in the courses offered for the degree.

2. Doctor of Philosophy (Geophysical Sciences). The requirements are:

a. A program of study approved by

the student's Advisory Committee, normally consisting of at least nine graduate courses.

b. A pass in a reading comprehension examination in two modern foreign languages, one of which must be Russian or German.

c. A preliminary examination consisting of a written part covering fields that the student has selected for his program of study, followed by an oral part based on the student's proposal for a dissertation topic that he has submitted as a reaseach prospectus.

d. A dissertation by the candidate on the results of independent research in the geophysical sciences, followed by an oral final examination on the dissertation and the field of specialization.

A more detailed statement of the program for the Ph.D. degree is available upon request from the Department Counsellor.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 132 | Physical and Chemical Evolution of the Solar Systems and Earth | 3 |
| 207 | Physicochemical Principles | 3 |
| 234 | Paleontology | 3 |
| 268 | Physics and Chemistry of the Atmosphere | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| 302 | Hydrodynamic Stability | 3 |
| 303 | Turbulence | 3 |
| 304 | Advanced Topics in Rotating Fluids | 3 |
| 335 | Paleo-Oceanography | 3 |
| 336 | Marine Paleoecology | 3 |
| 340 | Topics in Sedimentology | 3 |
| 343 | Ocean Wave Theory | 3 |
| 348 | Shallow-Water Oceanography | 3 |
| 350 | Phenomenology of Atmosphere and Oceans | 3 |
| 351 | Geophysical Fluid Dynamics I: Fundamentals | 3 |
| 352 | Geophysical Fluid Dynamics II: Viscous Flows | 3 |
| 353 | Geophysical Fluid Dynamics III: Waves | 3 |
| 354 | Geophysical Fluid Dynamics IV: Large-Scale Atmospheric Motions | 3 |
| 355 | Geophysical Fluid Dynamics V: Large-Scale Oceanic Motions | 3 |
| 356 | Geophysical Fluid Dynamics VI: Laboratory Models | 3 |
| 361 | Atmospheric Convection | 3 |
| 362 | Numerical Weather Prediction | 3 |
| 364 | Dynamics of Atmospheric Vortices | 3 |
| 368 | Radar Meteorology | 3 |
| 378 | Satellite Meteorology | 3 |
| 381 | Tides of the Geosphere | 3 |
| 385 | Seminar: Sediment Transport I | 3 |
| 395 | Radar Meteorology II | 3 |

RESEARCH COURSES

| | |
|---|---|
| 404 | Research in Fluid Mechanics |
| 441 | Research in Dynamical Oceanography |
| 461 | Research in Dynamical Prediction |
| 462 | Research in Hydrodynamical Models |
| 463 | Research in Experimental Hydrodynamic Stability |
| 464 | Research in Convection |
| 466 | Research in Theoretical Fluid Mechanics |
| 481 | Research in Marine Geophysics |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF THE GEOPHYSICAL SCIENCES

Clayton, Robert N., Ph.D., Professor of Geochemistry
Fultz, Dave, Ph.D., Professor of Meteorology and Student Counsellor
Johnson, Ralph G., Ph.D., Professor of Paleontology
Kuo, Hsiao-Lan, Ph.D., Professor of Meteorology
Lindzen, Richard S., Ph.D., Associate Professor of Meteorology
McGoldrick, Lawrence F., Ph.D., Assistant Professor of Fluid Mechanics
Miller, Robert L., Ph.D., Professor of Marine Geophysics
Pedlosky, Joseph, Ph.D., Associate Professor of Meteorology
Platzman, George W., Ph.D., Professor of Meteorology
Reid, William H., Ph.D., Professor of Applied Mathematics
Schopf, T. J. M., Assistant Professor of Paleontology

To obtain further information, address all inquiries directly to:

Dr. Julian R. Goldsmith
Department of the Geophysical Sciences
The University of Chicago
Chicago, Illinois 60637

## CLARK UNIVERSITY
### WORCESTER, MASSACHUSETTS

Although no degrees are given in Marine Science, per se, Biology Department members and graduate students conduct research in marine and related fields using the facilities at Clark and various marine laboratories. Close ties are maintained with the Bermuda Biological Station, Marine Biological Laboratory, Duke University Marine Laboratory, and the marine laboratory at St. Thomas, U.S. Virgin Islands. Computer facilities are available on campus. The R/V EASTWARD of Duke University is used regularly for oceanographic research, and student ten-day field trips to Bermuda are regularly scheduled.

The following courses related to marine science are offered:

| | |
|---|---|
| Bio 109 | Microbiology |
| Bio 111 | Zoology |
| Bio 114 | Phycology |
| Bio 117 | Principles of Ecology |
| Bio 215 | Invertebrate Zoology |
| Bio 217 | Biological Oceanography |
| Bio 231 | Bacterial Physiology |
| Bio 242 | Comparative Animal Physiology |
| Bio 248 | Sensory Physiology |
| Bio 360 | M.S. Dissertation |
| Bio 390 | Ph.D. Dissertation |

The instructional staff for the courses listed above consists of the following:

Coull, Bruce C., Ph.D.
Jahan-Parvar, Behrus, Ph.D.
Johansen, H. William, Ph.D.

Nunnemacher, Rudolph F., Ph.D.
Reynolds, John T., Ph.D.

To obtain further information, address all inquiries directly to:

Dr. Rudolph F. Nunnemacher
Chairman, Department of Biology
Clark University
Worcester, Massachusetts 01610

## COLUMBIA UNIVERSITY
### NEW YORK, NEW YORK

Graduate students in marine sciences at Columbia University normally enroll in the Department of Geology, those in marine biology enroll in the Department of Biological Sciences. There is no separate Department of Oceanography. Students follow a program of study based on the varied courses offered within these departments. The major research facilities for the marine sciences (along with an extensive oceanographic library and computer facilities) are located at the Lamont-Doherty Geological Observatory campus of Columbia University in Palisades, New York. At Lamont, research is conducted in physical, chemical, geophysical and biological oceanography as well as solid earth geophysics, geochemistry and meteorology.

The students have access to the material collected on numerous deep-sea expeditions of Lamont ships; among this data is the largest collection of deep-sea cores in the world. The Lamont-Doherty Observatory carries out oceanographic work aboard the 202-foot, 734-ton, 3-masted schooner, VEMA, and the 208-foot, 1370-ton AGOR-3, ROBERT D. CONRAD. In addition, polar oceanographic programs are conducted aboard the U.S.N.S. ELTANIN in conjunction with the Office of Antarctic Programs of the National Science Foundation, and the laboratories located on drifting ice in the Arctic Ocean.

The degrees of Master of Arts and Doctor of Philosophy are offered.

The following basic courses in marine sciences are offered by the Department of Geology. The exact curriculum to be followed by each student depends on his field of specialization and is decided upon by the student and his advisor. Other relevant courses are offered in the Departments of Physics, Chemistry, Biological Sciences and in the School of Engineering and Applied Science.

GEOLOGY DEPARTMENT

| | |
|---|---|
| W4010 | Chemical Geology II |
| W4928 | Submarine Geology |
| W4941 | Introduction to Geophysics |
| W4942 | Survey of Geophysical Prospecting |
| W4927 | Introduction to Oceanography |
| G6928 | Advanced Submarine Geology |
| G4945 | Geophysical Theory I |
| G4946 | Geophysical Theory II |
| G6930 | Dynamics of Ocean Currents |
| G9931 | Physical Oceanography Seminar |
| W4226 | Experimental Marine Sedimentology |
| G6223 | Principles of Sedimentation |
| G6908 | Analysis of Geophysical Data |
| G6681 | Micropaleontology I: Principles and Foraminifera |
| G6682 | Micropaleontology II: Radiolaria, Diatoms and Coccoliths |
| G9947 | Marine Geophysics Seminar |
| G6944 | Advanced Seismology I |
| G6949 | Advanced Seismology II |

The instructional staff for the courses listed above consists of the following:

Alsop, Leonard E., Adjunct Professor
Anderson, Orson L., Professor
Be, Allan W. H., Senior Research Associate, L-D.G.O.
Broecker, Wallace S., Professor
Donn, William L., Senior Research Associate, L-D.G.O.
Dorman, H. James, Lecturer, Senior Research Associate and Assistant Director, L-D.G.O.
Ewing, W. Maurice, Professor and Director, L-D.G.O.
Gast, Paul, Professor
Gordon, Arnold L., Assistant Professor
Hays, James D., Associate Professor
Hunkins, Kenneth L., Lecturer and Senior Research Associate, L-D.G.O.
Isacks, Bryan L., Adjunct Associate Professor
Kuo, John T., Professor (Mining)
McCamy, Keith, Lecturer
Nafe, John E., Professor
Oliver, Jack E., Professor
Roels, Oswald, Senior Research Associate, L-D.G.O.
Sykes, Lynn, Associate Professor
Talwani, Manik, Professor
Worzel, J. Lamar, Professor and Associate Director, L-D.G.O.

To obtain further information, address all inquiries directly to:

Professor Jack E. Oliver
Chairman
Department of Geology
Columbia University
New York, New York 10027

## UNIVERSITY OF CONNECTICUT
### STORRS, CONNECTICUT

To conduct its research efforts, the Marine Sciences Institute has facilities at two locations on the Connecticut shore, and operates three small research vessels at each site. The older of the two facilities is the Marine Research Laboratory at Noank, at the mouth of the Mystic River and about an hour from the main campus at Storrs; it has been operating since 1957 and specializes in biological research. This facility is a two-story brick building of some 7,000 square feet, housing laboratories, staff offices, a ship, and biology library. The building features a continuous-flow salt-water system, a 1,500-gallon aquarium, and conventional laboratory equipment for fisheries and biological research.

Adjoining the laboratory is a 125-foot long pier where the Noank fleet is docked, including a 65-foot converted T-boat, the U CONN, the 44-foot converted cabin cruiser, BEN GUNN, and a smaller 34-foot lobster boat, plus several skiffs and powered runabouts. The larger boats are fully equipped to handle the various research tasks mentioned above.

A few minutes to the west of Noank is the new Avery Point facility in Groton,

located at the Southeastern Branch of the University where the Thames River meets the sea, opposite New London. At Avery Point, the Institute has exclusive use of two large buildings, plus several smaller ones. The main building has approximately 17,000 square feet of floor space and has just been renovated for oceanographic research and staff offices. The second building, with 34,000 square feet of space, is now being renovated and is used for dry-laboratory work, teaching, machine fabrication, and storage. The smaller buildings are used by the ship's crew and as a place to repair oceanographic equipment and lay out equipment for cruises.

Some of the research equipment at Avery Point includes a ship-towed magnetometer, air-gun and sparker seismic sources, sono-buoys and receivers, current meters, a laboratory flume, a gas chromatograph, an X-ray diffraction unit, an underwater camera, sediment corers, rock dredges, earthquake seismometers, a machine and electronics shop, a 65-foot T-boat (the Navy owned T-441), a 40-foot research-converted cabin cruiser, the SEA HOSS, and a 36-foot cabin cruiser, the HARDLY EVER, which is used both as a research platform and a fifteen-knot shuttle to the Institute's other ships at sea. The dock also shelters a Boston Whaler and a skiff. (Deep water work is conducted on ships of other institutions.)

The Institute has its own IBM 2780 reader/printer remote computer terminal at Avery Point, which gives full access to the University's own IBM 360/65 over leased telephone lines.

The Institute is in the process of building up a marine library at Avery Point, housed in the Library Building of the Southeastern Branch.

The locations of the two facilities are ideal for the Institute's several missions-training graduate students, conducting research directly related to the marine environment, acting as an advisory or consulting body to the State and its various agencies, and offering credit extension courses to employees of the many maritime-related industries that cluster around New London and Groton.

The teaching program is directed toward graduate training. Graduate and graduate-credit courses are offered in the marine sciences and related fields. These courses, which supplement the research program, are offered by departments, so that M. S. and Ph. D. degrees can be earned in oceanography, biology, geophysics, geology, or engineering. The number of courses offered is being increased as the staff increases. Formal courses are offered either at Storrs or at Avery Point, depending primarily on student convenience at that time.

The following courses are offered in conjunction with the above programs:

ATMOSPHERIC SCIENCE

| | |
|---|---|
| 263 | Meteorology and Climatology |

BIOLOGY

| | |
|---|---|
| 236 | Marine Microbiology |
| 290 | Introductory Phycology |
| 395 | Independent Study |
| 396 | Investigations of Special Topics |
| 443 | Marine Ecology |
| 444 | Marine Ichthyology |
| 461 | Pathology of Invertebrates |

GEOLOGY

| | |
|---|---|
| 217 | Sedimentation |
| 305 | Special Problems in Geology |
| 314 | Micropaleontology I |
| 315 | Micropaleontology II |

GEOPHYSICS

| | |
|---|---|
| 264 | Physics of the Earth |
| 265 | Introduction to Geophysical Methods |
| 365 | Theoretical Seismology |
| 366 | Marine Acoustics |
| 367 | Earthquake Seismology |
| 400 | Special Topics in Geophysics |

OCEANOGRAPHY

| | |
|---|---|
| 272 | Marine Sciences I |
| 273 | Marine Sciences II |
| 370 | Physical Oceanography |
| 371 | Chemical Oceanography |
| 373 | Coastal Zone Processes |
| 374 | Geophysical Fluid Dynamics |
| 375 | Theories of Ocean Circulation |
| 410 | Special Topics in Oceanography |

The instructional staff for the courses listed above consists of the following:

Bohlen, Walter F., Ph.D., Assistant Professor, Physical Oceanography
Buck, John D., Ph.D., Assistant Professor, Microbiology
Chiburis, Edward F., Ph.D., Associate Professor, Geophysics
Dehlinger, Peter, Ph.D., Professor, Geophysics and Director of the Institute
Dowling, John J., Ph.D., Associate Professor, Geophysics
Feng, Sung Y., Ph.D., Associate Professor, Pathobiology
Fitzgerald, William F., Ph.D., Assistant Professor, Chemical Oceanography
Garvine, Richard W., Ph.D., Assistant Professor, Physical Oceanography
Libbey, Arthur J., Ph.D., Research Associate
Lund, William A., Jr., Ph.D., Associate Professor, Ichthyology
Nalwalk, Andrew J., Ph.D., Associate Professor, Marine Geology
Paskausky, David F., Ph.D., Assistant Professor, Physical Oceanography
Rankin, John S., Jr., Ph.D., Professor of Biology and Director of the Marine Research Laboratory (Noank)

To obtain further information, address all inquiries directly to:

MARINE SCIENCES (except biology)

Dr. Peter Dehlinger, Director
Marine Sciences Institute
University of Connecticut
Avery Point
Groton, Connecticut 06340

BIOLOGICAL OCEANOGRAPHY

Dr. John S. Rankin, Jr., Director
University of Connecticut
Marine Research Laboratory

Noank, Connecticut 06340

## CORNELL UNIVERSITY
### ITHACA, NEW YORK

Campus facilities such as modern laboratories for oceanographic and limnological teaching and research, experimental fish rearing ponds, and an aquatic weeds laboratory with 90 tenth-acre ponds, are complimented by shoreside laboratory facilities on Cayuga Lake and at the Cornell Oneida Lake field station. A developing field station at the Isles of Shoals, ten miles offshore in the Gulf of Maine, and a cooperative relationship with the Mote Marine Laboratory at Placida and Sarasota, Florida, provide direct access to the salt-water environment. Cornell faculty and students also regularly participate in programs utilizing resources of the Marine Biological Laboratory at Woods Hole, and the R/V EASTWARD of Duke University. As a member of the State University of New York, the statutory (state-supported) colleges at Cornell are associated in the program and facilities of the SUNY Marine Sciences Research Center on Long Island and the SUNY Water Resources Center at Syracuse with its concern for the two Great Lakes on New York's borders. Programs are backed by extensive general shops, laboratories, and computer resources, and one of the larger university library systems (over 3 million volumes) with exceptionally rich holdings in marine sciences.

The University owns, operates, or charters approximately a score of vessels and small boats for its various aquatic programs. In Ithaca, the 40-foot J. G. NEEDHAM is equipped for year-round work on the Finger Lakes. Other vessels are located at the Oneida Station and at the Isles of Shoals.

The following degrees in basic sciences and engineering include curricula with marine specialization. Requirements for each degree vary with the college and specialization administering it and are traditionally flexible with individual need:

1. A.B. in biology, chemistry, physics, geology.
2. B.S. in biology, engineering.
3. M.S. in biology, chemistry, physics, geology, engineering.
4. M. Engineering.
5. Ph.D. in biology, chemistry, physics, geology, engineering.

No sharp distinction is made between salt-water and fresh-water in Cornell's multidisciplinary program of aquatic studies which encompasses basic and applied curricula in the Colleges of Agriculture, Engineering, Arts and Sciences, and in the Cornell Water Resources and Marine Sciences Center. In addition to basic and supporting courses in the fundamental academic subjects, Cornell undergraduate and graduate students can develop degree programs which include regularly scheduled courses in oceanography, marine ecology, geological oceanography, invertebrate zoology, marine algae, ichthyology, micro- and invertebrate paleontology, fishery biology, climatology, hydrology, sedimentology, water resources management, ecosystems, environmental physiology, and water pollution. Supporting and advanced courses are found in the general areas of biology, limnology, conservation, engineering, and maritime law (Law School).

Although courses are not currently scheduled, Cornell staff includes persons with professional qualifications to teach and supervise research in marine bacteriology, marine mycology, marine virology, marine ornithology, diseases of marine animals (New York State Veterinary College), marine biochemistry, salt marsh ecology, and others.

Since 1966, Cornell has offered a summer course, "Introduction to Marine Science" at the Isles of Shoals. At present the course is being expanded through cooperation and participation of the University of New Hampshire and the State University of New York.

The following courses are offered in conjunction with the above programs. (Courses are generally open to both undergraduates and graduate students. Except for Engineering, the first digit indicates the general level of presentation; courses starting with 5 and above are intended primarily for graduate students. Additional research and seminar courses are available in many of these subjects by arrangement.)

NEW YORK STATE COLLEGE OF AGRICULTURE

DEPARTMENT OF AGRICULTURAL ENGINEERING

| | | |
|---|---|---|
| 321 | Introduction to Environmental Pollution | 2 |
| 506 | Industrial Waste Management | 3 |

DEPARTMENT OF AGRONOMY

| | | |
|---|---|---|
| 415 | Hydrometerology | 3 |
| 431 | Aquatic Plants | 3 |

DEPARTMENT OF CONSERVATION

| | | |
|---|---|---|
| 439,A | Fish Ecology | 4 |
| 440 | Fishery Science | 3 |
| 441 | Fishery Resource Management | 3 |
| 600 | Seminar: Major Fishery Investigations | 1 |
| 601 | Seminar: Selected Topics in Fishery Biology | 1 |

DEPARTMENT OF ENTOMOLOGY AND LIMNOLOGY

| | | |
|---|---|---|
| 572 | Advanced Limnology | 3 |

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

| | | |
|---|---|---|
| 412 | Aquatic Microbiology | 3 |

NEW YORK STATE COLLEGE OF AGRICULTURE AND COLLEGE OF ARTS AND SCIENCES

DIVISION OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 316 | Invertebrate Zoology | 4 |
| 344 | Phycology | 4 |
| 364 | Introduction to Marine Science | 4 |
| 460 | Marine Ecology | 3 |
| 461,A | Limnology | 4 |
| 462 | Oceanography | 3 |
| 469 | Biology of Fishes | 4 |
| 470 | Ichthyology | 4 |
| 665 | Environmental Physiology | 3 |

COLLEGE OF ARTS AND SCIENCES

DEPARTMENT OF GEOLOGICAL SCIENCES

| | | |
|---|---|---|
| 421 | Sedimentation | 4 |
| 444 | Geological Oceanography | 3 |
| 471 | Invertebrate Paleontology | 4 |
| 532 | Hydrogeology | 3 |

| | | |
|---|---|---|
| 690c | Seminar: Coastal Geomorphology | 0 |
| 690e | Seminar: Marine Geophysics | 0 |

COLLEGE OF ENGINEERING

DEPARTMENT OF WATER RESOURCES ENGINEERING

| | | |
|---|---|---|
| 2303 | Hydrology | 3 |
| 2310 | Dynamic Oceanography | 3 |
| 2320 | Analytical Hydrology | 3 |
| 2531 | Industrial Waste Management | |
| 2533 | Environmental Quality Control | 3 |
| 2593 | Water Resources Engineering Colloquium | 1 or 2 |

DEPARTMENT OF THERMAL ENGINEERING

| | | |
|---|---|---|
| 3642 | Pollution Problems | 3 |

The instructional staff for the courses and programs listed above consists of the following:

DEPARTMENT OF AGRICULTURAL ENGINEERING

Levine, Gilbert, Ph.D., Professor of Agricultural Engineering
Loehr, Raymond C., Ph.D., Professor of Agricultural Engineering and Professor of Civil and Environmental Engineering

DEPARTMENT OF AGRONOMY

Alexander, Martin, Ph.D., Professor of Soil Science
Dethier, Bernard E., Ph.D., Professor of Meteorology

DEPARTMENT OF CONSERVATION

Carlson, Clarence A., Ph.D., Assistant Professor Fishery Biology and Assistant Leader N.Y. Cooperative Fishery Unit
Eipper, Alfred W., Ph.D., Associate Professor of Fishery Biology and Leader N.Y. Cooperative Fishery Unit
Forney, John, Ph.D., Senior Research Associate in Fishery Biology and Project Leader, Warm Water Fisheries Investigation
Hewitt, Oliver H., Ph.D., Professor of Wildlife Management
Oglesby, Ray T., Ph.D., Associate Professor of Aquatic Science
Webster, Dwight A., Ph.D., Professor of Fishery Biology
Youngs, William D., Ph.D., Research Associate in Fishery Biology

DEPARTMENT OF ENTOMOLOGY AND LIMNOLOGY

Berg, Clifford O., Ph.D., Professor of Entomology and Limnology

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

Dondero, Norman C., Ph.D., Professor of Applied Microbiology

DIVISION OF BIOLOGICAL SCIENCES

Anderson, John M., Ph.D., Professor of Zoology
Barlow, John P., Ph.D., Associate Professor of Oceanography
Gilbert, Perry W., Ph.D., Professor of Neurobiology and Behavior and Director of the Mote Marine Laboratory
Kingsbury, John M., Ph.D., Professor of Botany
Likens, Gene E., Ph.D., Associate Professor of Zoology
McFarland, William N., Ph.D., Associate Professor of Zoology
Raney, Edward C., Ph.D., Professor of Zoology

DEPARTMENT OF GEOLOGICAL SCIENCES

Bloom, Arthur L., Ph.D., Associate Professor of Geological Sciences
Philbrick, Shailer S., Ph.D., Professor of Geological Sciences
Wells, John W., Ph.D., Professor of Geological Sciences

DEPARTMENT OF WATER RESOURCES ENGINEERING

Behn, Vaughn C., Dr. Eng., Associate Professor of Water Resources Engineering
Brutsaert, Wilfried, Ph.D., Associate Professor of Water Resources Engineering
Dworsky, Leonard B., M.A., Professor of Water Resources Engineering and Director of Cornell Water Resources and Marine Sciences Center
Gates, Charles D., M.S., Professor of Water Resources Engineering
Liggett, James A., Ph.D., Associate Professor of Water Resources Engineering
Loucks, Daniel P., Ph.D., Associate Professor of Water Resources Engineering

To obtain further information, address all inquiries directly to:

Water Resources and Marine Sciences Center
468 Hollister Hall
Cornell University
Ithaca, New York 14850

## THE UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

Facilities for marine research are located on the main campus in Newark and at the Field Station in Lewes, Delaware. Equipment and facilities available on the main campus support studies of shellfish culture, oyster pathology, salt marsh ecology, physiological ecology of marine organisms, marine pollution, coastal vegetation, benthic invertebrates, plankton, fishes, breakwater and cofferdam design, harbor construction, design and structural analysis of deep submergence test facilities, systems analysis of marine problems, dynamics of sediments in estuaries, coastal sedimentary processes, and organic geochemistry.

Field Station facilities encompass three sites involving approximately 20,000 square feet of research and teaching space. These laboratories are particularly accessible to a variety of marine habitats including the Atlantic Ocean, Delaware Bay and its tributaries, sand beaches, mud flats, salt marshes, rock jetties, sand dunes, and the full spectrum of estuarine conditions ranging from ocean to fresh water, all within five miles of the Field Station. A variety of field and laboratory equipment for use in marine ecological studies is available including nets,

dredges, bottom grabs, water samplers, coring devices, salinometers, fluorimeters, a fleet of small boats ranging in length from 10 to 17 feet, field vehicles, a 32-foot Chesapeake deadrise work boat, a 42-foot aluminum-hulled craft designed for hydrographic and plankton studies, and a 48-foot wooden-hulled trawler designed for exploratory fishing with trawl and dredges, geological sampling, and hydrographic work.

Marine studies have been conducted for more than 20 years at Delaware through programs in the departments of Biological Sciences, Civil Engineering, and Geology. The College of Marine Studies, established in 1970 as a logical consolidation and extension of marine activities, is an interdisciplinary graduate institution devoted to the study of marine biology, marine chemistry, marine geology, ocean engineering, oceanography, and the humanistic aspects of the marine environment.*

*Graduate degree programs bridging disciplinary areas through the College of Marine Studies to provide students with the opportunity to acquire broader training than is usually obtained by specialization within traditional departments are planned for the Fall of 1971.

The following degrees are currently offered by the University:

DEPARTMENT OF BIOLOGICAL SCIENCES

1. Bachelor of Science with option in Marine Biology-At least 30 semester hours which include the five core courses: B 201-Concepts in Biology, B 202-Developmental Biology, B 301-Cellular and Molecular Biology, B 302-Environmental Biology, and B 303-Genetic and Evolutionary Biology. These biology courses are supplemented with courses in chemistry, mathematics and physics, one foreign language, and advanced undergraduate/graduate marine biology courses which may be taken as electives.

2. Master of Science (with specialization in Marine Biology)-Students seeking the M.S. may choose either a thesis or a non-thesis program. The thesis program requiries 30 hours of courses (including an unspecified number in research) and demonstrated competence in a foreign language. Primary emphasis is on research that culminates in a written thesis and the oral defense of that thesis. The non-thesis program is designed primarily for high school and junior college teachers. It requires 30 hours of courses (including not more than three hours of research), demonstrated competence in a foreign language and passage of the Departmental Comprehensive Examination (see below).

3. Ph.D. Degree (with specialization in Marine Biology)-Students in the Ph.D. program are required to pass the Departmental Comprehensive Examination which consists of written examinations in 1) genetics and evolution, 2) physiology and biochemistry, 3) morphology, and 4) ecology. The predoctoral student must also pass an examination in his area of specialization and submit (and defend) an original research proposal; these are administered by his Advisory Committee.

Foreign language requirements may be fulfilled by: 1) demonstration of fluency in one language, or 2) demonstration of reading knowledge of two languages, or 3) demonstration of reading knowledge of one language and competence in statistics and computer science.

Predoctoral students normally carry on a planned reading program in preparation for the Comprehensive Examination and other degree requirements. Formal courses should be completed as soon as possible to allow time for independent study, research and seminars. Experience in the teaching of undergraduates is required of all candidates for the Ph.D. degree. It is expected that a significant portion of the dissertation will be suitable for publication.

DEPARTMENT OF GEOGRAPHY

1. Bachelor of Arts-Students majoring in geography must complete a minimum of 30 credit hours in the department including the following required courses: G 201-Physical Geography, G 202-Cultural Geography, and G 645-Geography Methods and Theory. In addition, majors are expected to take Statistics 201 or an equivalent course acceptable to the department. During the Senior year, majors will complete a research project or Senior thesis.

DEPARTMENT OF GEOLOGY

1. Bachelor of Science with option in Marine Geology-Thirty credit hours in basic geology inclusing General Geology, Mineralogy and Optical Mineralogy, Paleontology, Sedimentation and Stratigraphy, Igneous and Metamorphic Petrology, and Structural Geology. Fifteen elective credits of additional geology, marine-oriented geology courses, and/or marine-oriented courses in related science disciplines. The Bachelor of Science also requires 24 credits of basic physics and chemistry and mathematics through calculus with a possible statistics option, and one foreign language.

2. Master of Science in Geology-Thirty credit hours on the graduate level including thesis, and an area of specialization within the many geologic sub-disciplines. The Master of Science degree may be specifically oriented to Marine Geology. A qualifying written examination must be taken at least nine months before the date of anticipated graduation. Demonstrated ability to read scientific literature in one foreign language (French, German, Russian). An oral examination is administered by the student's thesis committee after completion of the M.S. thesis.

3. Ph.D. in Geology-The general requirements imposed by the University of Delaware. Oral and written qualifying examinations in which the student deomostrates: a) The breadth and depth of his knowledge of major geologic phenomena and processes; b) His knowledge of his field of specialization (e.g., sedimentation-stratigraphy, marine geology, geo-chemistry) within the broader field of geology; c) His knowledge of a minor field related to his area of specialization; d) A final oral examination; and e) One foreign language-French, German, Russian.

The following courses are offered in conjunction with the above programs:

BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| B 627 | Introduction to Oceanography | 4 |
| B 628 | Marine Biology | 6 |
| B 629 | Physical Oceanography | 3 |
| B 630 | Ichthyology | 4 |
| B 631 | Biological Oceanography | 4 |
| B 634 | Invertebrate Zoology | 4 |
| B 638 | Marine Botany | 3 |
| B 639 | Topics in Marine Ecology | 3 |
| B 666 | Special Problems | 1-6 |
| B 827 | Seminar in Marine Sciences | 2-4 |
| B 828 | Marine Invertebrates | 4 |
| B 838 | Marine Fouling | 3 |



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| | | |
|---|---|---|
| B 860 | Estuarine Hydrography | 4 |
| B 866 | Special Problem | 1-6 |
| B 867 | Seminar | 1 |
| B 868 | Research | 1-9 |
| B 869 | Master's Thesis | 1-6 |
| B 969 | Ph.D. Dissertation | 1-12 |

GEOGRAPHY

| | | |
|---|---|---|
| G 220 | Meteorology | 3 |
| G 320 | Water Resources | 3 |
| G 660 | Problems in Marine Geography | 3 |

GEOLOGY

| | | |
|---|---|---|
| GEO 611 | Quantitative Geomorphology | 3 |
| GEO 631 | Marine Geology | 3 |
| GEO 632 | Geology of Recent Sedimentary Environments | 3 |
| GEO 634 | The Geology of Coasts | 3 |
| GEO 635 | Introduction to Marine Sedimentology | 1 |
| GEO 636 | Introduction to Marine Organic Sedimentology | 1 |
| GEO 637 | Introduction to Marine Micropaleontology | 1 |
| GEO 638 | Field Methods in Inorganic Geochemistry | 1 |
| GEO 639 | Coastal Geohydrology | 1 |
| GEO 655 | Field Methods in Marine Geophysics | 1 |
| GEO 666 | Special Problems | 1-6 |
| GEO 821 | Hydrogeology | 3 |
| GEO 846 | Low-Temperature Geochemistry | 3 |
| GEO 853 | Applied Seismology | 3 |
| GEO 866 | Special Problems | 1-6 |
| GEO 869 | Thesis | 1-6 |
| GEO 969 | Doctoral Dissertation | 1-12 |

The University also offers undergraduate and graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

COLLEGE OF MARINE STUDIES

There are approximately 30 faculty at the University of Delaware who pursue marine related studies. Of these about two thirds are affiliated with the College of Marine Studies and are listed below.

Biggs, Robert R., Ph.D., Associate Professor (Also Associate Professor of Geology)
Camfield, Frederick E., Ph.D., Assistant Professor (Also Assistant Professor of Civil Engineering)
Costello, Frederick A., Ph.D., Associate Professor (Also Associate Professor of Mechanical and Aeorspace Engineering)
Daiber, Franklin C., Ph.D., Professor (Also Professor of Biological Sciences)
Epifanio, Charles E., Ph.D., Assistant Professor of Marine Biology
Gaither, William S., Ph.D., Dean and Professor
Glass, Billy, Ph.D., Assistant Professor (Also Assistant Professor of Geology)
Jordan, Robert R., Ph.D., Associate Professor (Also Associate Professor of Geology)
Kinsman, Blair, Ph.D., Professor
Kraft, John C., Ph.D., Professor (Also Professor of Geology)
Kupferman, Stuart L., Ph.D., Assistant Professor
Lotrich, Victor A., Ph.D., Assistant Professor (Also Assistant Professor of Biological Sciences)
Mather, John R., Ph.D., Professor (Also Professor of Geography)
Maurer, Donald L., Ph.D., Assistant Professor of Marine Biology (Also Assistant Professor of Biological Sciences)
Merceret, Francis J., B.S., Lecturer
Myers, Thomas D., Ph.D., Assistant Professor of Marine Biology (Also Assistant Professor of Biological Sciences)
Polis, Dennis F., Ph.D., Assistant Professor
Price, Kent S., Ph.D., Assistant Dean and Assistant Professor of Marine Biology (Also Assistant Professor of Biological Sciences)
Sheridan, Robert E., Ph.D., Assistant Professor (Also Assistant Professor of Geology)
Somers, G. Fred, Ph.D., H. Fletcher Brown Professor (Also Professor of Biological Sciences)
Swain, Frederick M., Ph.D., Professor (Also Professor of Geology)
Taylor, Jonathan E., Ph.D., Assistant Professor of Marine Biology (Also Assistant Professor of Biological Sciences)
Wang, Hsiang, Ph.D., Associate Professor (Also Associate Professor of Civil Engineering)

DEPARTMENT OF GEOGRAPHY

Field, Richard T., M.S., Lecturer
Mather, John R., Ph.D., Professor and Chairman
Swaye, F. J., M.A., Instructor

To obtain further information, address all inquiries directly to:

Dr. William S. Gaither, Dean
College of Marine Studies
University of Delaware
Newark, Delaware 19711

## DUKE UNIVERSITY
### DURHAM, NORTH CAROLINA

The Duke University Marine Laboratory (DUML) is an interdepartmental and interuniversity facility for training and research in the marine sciences. It is open throughout the year with an academic and technical staff in residence. It presently occupies 15 acres of the southern portion of Pivers Island, Beaufort, North Carolina. The U.S. Bureau of Commercial Fisheries Biological and Radiobiological Laboratories encompass the remainder of the island, the northern end. The present plant consists of 18 buildings, including three dormitories capable of housing 46 people, a large dining hall, two residences, boat house, store house for ship's gear, classroom laboratories and five air-conditioned research buildings.

The Station operates a well-equipped 118-foot research vessel EASTWARD for training and research in oceanography, a 55-foot trawler for off-shore investigations, and a 39-foot cabin powerboat for trawling and dredging in surrounding sounds and estuaries. A 17-foot fiberglass speedboat, rowboats with outboard motors, and collecting gear are also

available. The DUML library receives 125 current periodicals and is complemented by added holdings of the Bureau of Commercial Fisheries Laboratories and the University of North Carolina Institute of Marine Science which are located in the Beaufort-Morehead City area.

Separate degrees are not offered in the marine sciences, but a student may pursue work for the A.M. and Ph.D. degrees in Botany and Zoology with concentration of courses in Marine Biology and Oceanography and a thesis in one of these areas. For the A.M. degree in Geology, course work may be taken and a thesis written in Marine Geology or Geological Oceanography. A B.S. in Geology is offered with a curriculum preparatory to advanced studies in oceanography.

In Botany the student's graduate program is planned to provide broad basic training in the various fields of botany, plus intensive specialization in the field of the research problem. Graduate courses in the Department of Geology are designed to provide training in the field of sedimentary geology and micropaleontology. Areas of specialization in thesis research include continental shelf sedimentation, deep-sea sedimentation, micropaleontology of deep sea sediments, and carbonate sedimentation.

Required work for the A.M. degree in zoology ordinarily includes 12 units of advance course work in zoology, 6 units of course work in a minor department, and an additional 6 units of advanced work in the major or minor department, or in other pertinent departments. Furthermore, an acceptable thesis is necessary for the fulfillment of the degree requirements.

Normally the degree program for the Ph.D. degree includes graduate courses in several fields of zoology, courses in the minor subject, wide reading in science in general and in biology in particular, research, and a disseration based on original work. Minor work is available in many fields, including anatomy, biochemistry, botany, chemistry, geology, physics, physiology, psychology, and engineering.

A graduate student working for the Ph.D. degree usually takes course work on the main Durham Campus during the academic year and more specialized courses in the summer in the marine sciences at the Duke University Marine Laboratory. By the end of his second year, he is expected to have passed an oral preliminary examination in his department. Thereafter, he is free to do his thesis research without further course requirements on the Durham and/or DUML campuses.

Training in the marine sciences at Duke University and the Duke University Marine Laboratory is at the senior-graduate level in the departments of Botany, Geology and Zoology. Students are free to elect courses in any of the science departments including those in the Schools of Medicine and Engineering. Research and courses exist in the School of Engineering in the areas of communication theory, stochastic information processing, decision theory, digital computer systems, ocean structures and coastal formations.

The following courses are offered in conjunction with the above programs:

BOTANY

SENIOR-GRADUATE

| | | |
|---|---|---|
| 205 | Marine Microbiology | 6 |
| 207 | Marine Mycology | 6 |
| 211 | Marine Phycology | 6 |
| 220 | Coastal Field Botany | 6 |
| 225 | Special Problems | 3 |
| 226 | Special Problems | 3 |
| 255 | Plant Systematics | 4 |
| 259 | The Environment Seminar | 4 |

GRADUATE

| | |
|---|---|
| 359 | Research in Botany |
| 360 | Research in Botany |

BIOCHEMESTRY

SENIOR-GRADUATE

| | | |
|---|---|---|
| 276 | Comparative and Evolutionary Biochemistry | 6 |

GEOLOGY

SENIOR-GRADUATE

| | | |
|---|---|---|
| 205 | Geological Oceanography | 6 |
| 206 | Principles of Geological Oceanography | 3 |
| 208 | Shallow-Marine Geology | 3 |
| 213 | Sedimentology | 3 |
| 214 | Sediments in Thin Section | 3 |
| 222 | Sedimentary Minerals | 3 |
| 243 | Micropaleontology | 3 |
| 244 | Micropaleontology | 3 |
| 247 | Paleoecology | 3 |

GRADUATE

| | |
|---|---|
| 300 | Seminar in Oceanography |
| 312 | Seminar in Sedimentology |

PHYSIOLOGY

GRADUATE

| | | |
|---|---|---|
| M394 | Marine Membrane Physiology | 6 |

ZOOLOGY

SENIOR-GRADUATE

| | | |
|---|---|---|
| 203 | Marine Ecology | 6 |
| 214 | Biological Oceanography | 6 |
| 216 | Limnology | 3-4 |
| 238 | Systematic Zoology | 4 |
| 240 | Chemical Oceanography | 6 |
| 250 | Physiological Ecology of Marine Animals | 6 |
| 274 | Marine Invertebrate Zoology | 6 |
| 276 | Comparative and Evolutionary Biochemistry | 6 |
| 278 | Invertebrate Embryology (when required) | 4 or 6 |

GRADUATE

| | |
|---|---|
| 351 | Departmental Seminar |
| 352 | Departmental Seminar |
| 353 | Research |
| 354 | Research |
| 355 | Seminar |
| 356 | Seminar |
| | Advanced Oceanographic Seminar |

The instructional staff for the courses

listed above consists of the following:

BIOCHEMISTRY DEPARTMENT

Sullivan, James B., III, Ph.D., Assistant Professor of Biochemistry

BOTANY DEPARTMENT

Barber, Richard T., Ph.D., Associate Professor of Botany and Zoology, Marine Ecology
Billings, William Dwight, Ph.D., James B. Duke Professor of Botany, Plant Ecology
Johnson, Terry W., Ph.D., Chairman and Professor of Botany, Marine Mycology
Searles, Richard B., Ph.D., Associate Professor of Botany, Marine Phycology
Wilbur, Robert L., Ph.D., Professor of Botany, Plant Systematics

GEOLOGY DEPARTMENT

Heron, Stephen Duncan, Ph.D., Chairman and Associate Professor of Geology, Sedimentary Petrology
Lynts, George W., Ph.D., Assistant Professor of Geology, Micropaleontology
Perkins, Ronald, Ph.D., Associate Professor of Geology, Sedimentology
Pilkey, Orrin H., Ph.D., Associate Professor of Geology, Marine Geology

PHYSIOLOGY DEPARTMENT

Gutnecht, John, Ph.D., Assistant Professor of Physiology

ZOOLOGY DEPARTMENT

Bailey, Joseph R., Ph.D., Professor of Zoology, Vertebrate and Systematic Zoology
Barber, Richard T., Ph.D., Associate Professor of Botany and Zoology, Marine Ecology
Brookhout, Cazlyn G., Ph.D., Professor of Zoology & Acting Director of Oceanographic Program, Invertebrate Embryology and Zoology
Costlow, John D., Jr., Ph.D., Professor of Zoology and Director of Duke University Marine Laboratory, Invertebrate Embryology and Zoology
Doyle, Roger, Ph.D., Assistant Professor of Zoology, Ecology and Biological Oceanography
Fluke, Donald J., Ph.D., Chairman and Professor of Zoology, Biophysics
Gray, Irving D., Ph.D., Professor of Zoology (Retired), Ecology
Livingstone, Daniel A., Ph.D., Professor of Zoology, Limnology
Lundberg, John G., Ph.D., Assistant Professor of Zoology, Vertebrate and Systematic Zoology
Sutherland, John P., Ph.D., Assistant Professor of Zoology, Marine Ecology
Wainwright, Stephen A., Ph.D., Associate Professor of Zoology, Invertebrate Zoology
Wilbur, Karl M., James B. Duke Professor of Zoology, Cellular Physiology

CIVIL ENGINEERING DEPARTMENT

Muga, Bruce J., Ph.D., Associate Professor of Civil Engineering

ELECTRICAL ENGINEERING DEPARTMENT

Nolte, Loren W., Ph.D., Associate Professor of Electrical Engineering

MECHANICAL ENGINEERING DEPARTMENT

Linderoth, L. Sigfred, Jr., M.E., Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Director of Graduate Studies of the Department of particular interest

or

Dean of the Graduate School
Duke University
Durham, North Carolina 27706

For summer courses at DUML

Dr. John C. Costlow, Jr., Director
Duke University Marine Laboratory
Beaufort, North Carolina 28516

## FLORIDA ATLANTIC UNIVERSITY
### BOCA RATON, FLORIDA

Florida Atlantic University offers ocean engineering and marine science courses at its main campus in Boca Raton, Florida. Florida Atlantic University is an upper division university (junior and senior years plus graduate work) which includes a College of Science and a separate Department of Ocean Engineering. It is a part of the State of Florida University system. Students entering FAU must have successfully completed two years at a junior college or the equivalent at a four year institution and meet the prerequisites of the department they desire to enter.

The Department of Biological Sciences is housed in a new five-story building which includes modern laboratory facilities for teaching and research in the area of botany, microbiology, and zoology. Faculty interest and research are strongly oriented toward tropical inshore marine biology with particular emphasis on ecology and environmental contamination. Joint graduate training programs and marine science seminars are also conducted through direct affiliation of the Department with the U.S. Bureau of Commercial Fisheries Tropical Atlantic Biological Laboratory in Miami.

The University offers the degree of M.S. in Biological Sciences (Department of Biological Sciences). All students are required to obtain practical research experience in biological sciences with an emphasis in the area of botany, microbiology, or zoology, and to demonstrate competence in one of these areas by satisfactorily completing a comprehensive examination and thesis research. Each student is required to satisfactorily complete a minimum of 45 quarter credit hours of courses, six quarter credits of which may be in undergraduate-level courses, including up to six quarter credits of thesis research. Each student must also demonstrate a reading knowledge of a modern foreign language, usually French, German, or Russian.

Courses in the marine sciences are offered during the academic year by the departments of Biological Sciences, Geography (Geology), and Ocean Engineering. Both Bio-

logical Sciences and Ocean Engineering offer regular summer and special workshop courses on the Boca Raton campus.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| 315 | Survey of Marine Biology | 3 |
| 431 | Thallophytes | 5 |
| 438 | Invertebrate Zoology I | 4 |
| 439 | Invertebrate Zoology II | 4 |
| 448 | Evolution and the Environment | 4 |
| 452 | Comparative Animal Physiology I | 4 |
| 453 | Comparative Animal Physiology II | 4 |
| 518 | General Mycology | 5 |
| 543 | Taxonomy of Fishes | 4 |
| 545 | Biosystematics | 5 |
| 575 | Ethology | 4 |
| 581 | Marine Biology | 4 |
| 624 | Microbial Physiology in the Sea | 3 |
| 626 | Applied Microbiology | 5 |
| 627 | Microbial Ecology | 5 |
| 628 | Pathogenic Microbes of Marine Organisms | 3 |
| 644 | Biology of Fishes | 4 |
| 645 | Marine Invertebrate Zoology I | 4 |
| 646 | Marine Invertebrate Zoology II | 4 |
| 654 | Physiological Animal Ecology | 5 |
| 661 | Algology | 4 |
| 683 | Marine Ecology | 5 |
| 699 | Masters' Thesis Research | 1-9 |

The University also offers undergraduate and graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGICAL SCIENCES

Ache, Barry W., Ph.D., Physiology, Ethology
Adams, Ralph M., Ph.D., Ecology
Austin, Daniel, Ph.D., Plant Taxonomy, Biosystematics
Courtenay, Walter R., Jr., Ph.D., Ichthyology
Dobkin, Sheldon, Ph.D., Invertebrate Zoology
Grimm, Robert B., Ph.D., Algology
Hoffmann, Harrison A., Ph.D., Microbiology
Marsh, G. Alex, Ph.D., Marine Ecology
Sguros, Peter L., Ph.D., Marine Mycology, Biochemistry

ADJUNCT FACULTY

Andrews, Donald H., Ph.D., Biophysics
Beardsley, Grant, Ph.D., Fishery Biology
Davis, William P., Ph.D., Ichthyology, Marine Ecology
Dragovich, Alexander, M.S., Fishery Biology
Hebard, James Frank, Ph.D., Oceanography
Jones, Albert C., Ph.D., Fishery Biology, Biostatistics
Kalber, Frederick, Ph.D., Invertebrate Physiology
Miller, George C., M.S., Ichthyology
Miller, Robert V., Ph.D., Ichthyology
Richards, William J., Ph.D., Ichthyology
Sinderman, Carl J., TABL Director, Parasitology
Teigland, Melbourne B., D.V.M., Veterinary Medicine
Warren, Joel F., Ph.D., Virology
Wise, John P. M.S., Fishery Biology

To obtain further information, address all inquiries directly to:

Dr. Harrison A. Hoffmann, Acting Chairman
Department of Biological Sciences
Florida Atlantic University
Boca Raton, Florida 33432

## FLORIDA INSTITUTE OF TECHNOLOGY
MELBOURNE, FLORIDA

A new Science Building has just been completed having classrooms and three laboratories for oceanographic research and educational purposes-chemical, biological, and physical. Also in the building are a 10,000 curie cobalt facility, a Sigma 5 computer and a terminal connected to a CDC 6600 complex. The Department of Oceanography presently has a 65-foot ocean-going research vessel as well as two houseboats outfitted as mobile laboratories for estuarine research.

The Institute offers an undergraduate and a graduate program in Oceanography with graduate level options in Physical or Bio-environmental Oceanography.

1. M.S. in Oceanography. The degree of Master of Science in Oceanography may be conferred upon students who have successfully completed a minimum of 48 quarter hours of required and elective work. Applicants for admisssion to the program should have a Bachelor's degree in physics, mathematics, physical science, or engineering from an institution acceptable to the Graduate School. All Physical Oceanography graduate students are required to have a mathematical background through differential equations and one year of chemistry. Admission to the Graduate School does not imply that all work taken by the student will be credited toward a degree. All graduate students are required to write a Master's thesis.

2. B.S. in Oceanography. In addition to a basic program in Physics, undergraduate students will take such courses as introduction to oceanography, marine geology and geophysics, chemical and physical oceanography, marine meteorology, ocean waves, and hydroacoustics. Some field work will be included and each student must complete an undergraduate project.

Florida Institute of Technology holds a six-weeks pre-college summer institute for high school seniors and graduates who desire additional training in science and mathematics before entering college. The Institute gives the student special courses in Mathematics, Physics, Chemistry, Oceanography, Space Technology, and English. A special guidance and testing seminar assists the students in discovering the fields for which they are best suited.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| B 101 | General Biology I | 3 |
| B 102 | General Biology II | 3 |
| B 103 | General Biology III | 3 |
| C 101 | Chemistry | 4 |
| C 102 | Chemistry | 4 |
| C 103 | Chemistry | 4 |
| B 401 | Biological Systems | 3 |

| | | |
|---|---|---|
| O 301 | Introduction to Oceanography | 3 |
| O 302 | Chemical Oceanography | 3 |
| O 303 | Physical Oceanography | 4 |
| O 401 | Marine Geology | 3 |
| O 402 | Ocean Waves and Currents | 3 |
| O 403 | Marine Geophysics | 3 |
| O 451 | Hydroacoustics | 3 |
| O 452 | Marine Meteorology | 2 |
| O 491 | Senior Project | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| O 500 | Introduction to Physical Oceanography | 3 |
| O 501 | Geological Oceanography | 3 |
| O 502 | Biological Oceanography | 3 |
| O 503 | Chemical Oceanography I | 3 |
| O 504 | Chemical Oceanography II | 3 |
| O 506 | Sea Lab Techniques | 2 |
| O 508 | Optical Oceanography | 3 |
| O 510 | Seminar | 1 |
| O 511 | Tides and Tidal Currents | 3 |
| O 512 | Dynamic Oceanography I | 3 |
| O 513 | Dynamic Oceanography II | 3 |
| O 516 | Marine Meteorology | 3 |
| O 520 | Hydroacoustics I | 3 |
| O 521 | Hydroacoustics II | 3 |
| O 531 | Ocean Waves I | 3 |
| O 532 | Ocean Waves II | 3 |
| O 540 | Statistical Methods in Oceanography | 3 |
| O 550 | Special Topics in Physical Oceanography | 1 |
| O 551 | Special Topics in Physical Oceanography | 1 |
| O 552 | Special Topics in Physical Oceanography | 1 |
| O 571 | Principles of Environmental Biology I | 5 |
| O 572 | Principles of Environmental Biology II | 5 |
| O 597 | Thesis | 3 |
| O 598 | Thesis | 3 |
| O 599 | Thesis | 3 |

The instructional staff for the courses listed above consists of the following:

Dubbelday, Pieter S., Ph.D., Professor of Oceanography and Physics
Lasater, James A., Ph.D., Professor of Oceanography
Mertens, Lawrence, Ph.D., Adjunct Professor of Oceanography
Norton, Marvin, M.S., Adjunct Lecturer in Oceanography
Paltzik, Allen, M.S., Assistant Professor of Chemistry
Phillips, David R., M.S., Adjunct Lecturer in Oceanography
von Zweck, Ortwin, Ph.D., Assistant Professor of Oceanography
Webster, George C., Ph.D., Head of Biological Sciences Department
Woodbridge, David, Ph.D., Director of Research

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Florida Institute of Technology
Melbourne, Florida 32901

## FLORIDA STATE UNIVERSITY
### TALLAHASSEE, FLORIDA

Specialized facilities at the main campus in Tallahassee include a computing center with a CDC 6400, an IBM 1401 and an EAI 3500 data plotter as well as a statistical consultation center. Laboratories are available for research in biological, chemical, geological, physical and dynamical oceanography. Equipment includes rotating and convective motion tanks, wind tunnel, instruments and electronic laboratories, and shop facilities.

A shore facility at Turkey Point on the Gulf of Mexico, 46 miles from the campus, includes laboratories, shop facilities, classrooms and dormitories. It has a 180-foot by 200-foot boat basin and a 180-foot dock for vessels with draft less than 12 feet. Research vessels available are a 65-foot vessel with collecting equipment, a 30-foot cabin cruiser and small boats.

The following degrees are offered:

1. B.S. and B.A. Curricula are available for undergraduate degrees in Biological Sciences and in Meteorology. In each department it is possible to elect certain undergraduate marine science courses and during the senior year to elect graduate courses from the Oceanography Department.

A new curriculum providing an oceanography option for undergraduate majors in the physics department is now available.

2. M.S. in Marine Biology (Department of Biological Science). The department requires the advance test in biology and a score of at least 1100 on the aptitude portion of the Graduate Record Examination. Thesis type programs are offered in the following areas: marine invertebrate behavior, invertebrate zoology, marine ecology, marine phycology, phytoplankton ecology, physiological ecology, comparative physiology of marine invertebrates, biological aspects of industrial pollution.

3. Ph.D. in Marine Biology (Department of Biological Science). Admission is determined by evaluation of transcripts, letters of recommendation, G.R.E. scores (1100) and interview results when possible. Capacity for critical scholarly work of professional quality is required. There is no minimum course requirement other than that inferred by residence requirement (continuous full-time residence of three quarters with minimum of 12 quarter hours per quarter) after earning Master's degree or 48 hours of graduate credit. Individual programs are planned to afford the student sufficient mastery of scholarly methods, subject matter of his special field, and general knowledge for best performance on preliminary examinations. Subject matter areas are as listed under Master of Sciences.

4. M.S. in Oceanography (Thesis program only). Students may specialize in each of four areas: biological, chemical, geological or physical oceanography, or in combinations of these areas. Admission requires an undergraduate average of B and a G.R.E. score (verbal and computational) of 1100, plus one year each of college chemistry and college physics and mathematics through one year of calculus. Students must pass a qualifying examination, complete 45 quarter hours of course work, and write an acceptable thesis. At least three quarters must be completed in residence.

5. Ph.D. in Oceanography. Areas of specialization are the same as for the M.S. degree. Admission requirements include those for the M.S., plus strong evidence of ability to do original research, and usually a Master's degree. A qualifying examination,

an examination for admission to candidacy and a defense of thesis are required. At least three quarters of continuous enrollment must be spent at FSU. A student must write a Ph.D. thesis which constitutes a significant contribution to knowledge.

6. Ph.D. in Geophysical Fluid Dynamics. This is an interdepartmental program in theory of fluids with a Ph.D. degree only. Students may specialize in theory of dynamical oceanography. Admission requirements and degree requirements include those for oceanography, but advanced study in mechanics, mathematics and physics is required before application for admission. Students must apply directly to Program Supervisor, Geophysical Fluid Dynamics Institute.

The following courses are offered in conjunction with the above programs. All course credits given are in quarter hours.

## UNDERGRADUATE COURSES

### ANTHROPOLOGY

| | | |
|---|---|---|
| 404 | Introduction to Zooarchaeology | 3 |

### BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 421 | General Ecology | 5 |
| 430 | General Marine Biology | 4 |
| 463 | Introductory Phycology and Marine Botany | 4 |

### GEOGRAPHY

| | | |
|---|---|---|
| 465 | Geography of the Oceans | 3 |

### METEOROLOGY

| | | |
|---|---|---|
| 173 | Air and Water Pollution | 3 |
| 339 | Marine Climatology | 3 |
| 423 | Atmospheric Motions | 3 |
| 429 | Introduction to Geophysical Fluid Dynamics | 3 |
| 441 | Geophysical Measurements | 3 |
| 463 | Atmospheric Radiation | 3 |

## GRADUATE COURSES

### ANTHROPOLOGY

| | | |
|---|---|---|
| 502 | Seminar in Zooarchaeology | 3 |
| 540 | Zooarchaeology of the Gulf Coastal Plain | 3 |
| 591 | Directed Individual Study | 3 |

### BIOLOGICAL SCIENCE

| | | |
|---|---|---|
| 521 | Biogeography | 3 |
| 525 | Limnology | 4 |
| 531 | Marine Ecology | 3 |
| 533 | Malacology | 3 |
| 536 | Ichthyology | 4 |
| 556 | Topics in Ecology | 4 |
| 563 | Advanced Phycology and Algal Ecology | 4 |
| 572 | General Microbiology | 4 |
| 573 | General Microbiology | 4 |
| 574 | General Microbiology | 4 |
| 636 | Advanced Ichthyology | 4 |

### ECONOMICS

| | | |
|---|---|---|
| 554 | Economics of Ocean Resources | 3 |

### GEOGRAPHY

| | | |
|---|---|---|
| 565 | Geography of the Oceans | 3 |

### GEOLOGY

| | | |
|---|---|---|
| 524 | Coastal Plain Geology | 5 |
| 561 | Introduction to Wave Theory | 3 |
| 566 | Model Theory | 1 |
| 568 | Wave Propagation Theory | 3 |

### OCEANOGRAPHY

| | | |
|---|---|---|
| 500 | Elementary Physical Oceanography | 3 |
| 501 | Introduction to Physical Oceanography | 3 |
| 502 | Dynamic Oceanography I | 3 |
| 503 | Dynamic Oceanography II | 3 |
| 504 | Marine Hydrodynamics | 3 |
| 505 | Ocean Waves | 3 |
| 506 | Ocean Circulation | 3 |
| 507 | Turbulence | 3 |
| 508 | Geophysical Measurements | 3 |
| 509 | Estuary and Coastline Hydrodynamics | 3 |
| 514 | Dynamics of the Upper Ocean | 3 |
| 515 | Experimental Oceanography | 4 |
| 518r | Special Problems in Physical Oceanography | 3 |
| 520 | Elementary Biological Oceanography | 3 |
| 522 | Ecology and Taxonomy of Benthic Communities | 3 |
| 523 | Zooplankton Ecology | 4 |
| 524 | Marine Phytoplankton Ecology | 3 |
| 525 | Marine Phytoplankton Physiology | 3 |
| 526r | Selected Topics in Marine Phytoplankton | 3 |
| 527 | Fishery Biology | 3 |
| 528r | Special Problems in Biological Oceanography | 3 |
| 531 | Marine Ecology | 3 |
| 532 | Estuarine Biology | 3 |
| 535 | Estuarine Pollution | 3 |
| 540 | Elementary Chemical Oceanography | 3 |
| 541 | Marine Chemistry | 3 |
| 545 | Chemical Limnology | 3 |
| 548r | Special Problems in Chemical Oceanography | 3 |
| 551 | Introduction to Fluid Dynamics | 3 |
| 552 | Geophysical Applications of Fluid Dynamics | 3 |
| 553 | Geophysical Applications of Fluid Dynamics | 3 |
| 557 | Physics of the Air-Sea Boundary Layer | 3 |
| 558 | Laboratory in Air-Sea Interaction | 5 |
| 561 | Oceanic Biogeography | 3 |
| 562 | Geomicrobiology | 3 |
| 564 | Marine Microbiology | 4 |
| 570 | Elementary Geological Oceanography | 3 |
| 571 | Geochemistry | 3 |
| 572 | Geochemistry | 3 |
| 574 | Shoreline Geology | 3 |
| 575 | Shoreline Geology | 2 |
| 578r | Special Problems in Geological Oceanography | 3 |
| 580 | Advanced Sedimentology | 4 |
| 581 | Bathymetry, Structure and Tectonics of the Ocean Basins | 4 |
| 582 | Oceanic Processes of Sedimentation | 3 |
| 583 | Ocean Sediments | 3 |
| 586 | Environments of Marine Deposition | 4 |
| 591r | Directed Individual Study | 3-12 |
| 595r | Oceanography Seminar | 1 |
| 597r | Directed Research | 1-9 |
| 598r | Directed Teaching | 1-9 |
| 599 | Thesis | 5-9 |
| 629r | Advanced Topics in Geophysical Fluid Dynamics | 3 |

| | | |
|---|---|---|
| 681r | Advanced Topics in Hydrodynamics | 3 |
| 695r | Seminar | 1 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF ANTHROPOLOGY

Olsen, Stanley J., Associate Professor
Percy, George, Ph.D., Assistant Professor
Smith, Hale G., Ph.D., Professor

DEPARTMENT OF BIOLOGICAL SCIENCE

Collier, Albert, B.A., Professor
Easton, Dexter M., Ph.D., Associate Professor
Friedmann, Imre, Ph.D., Associate Professor
Greenberg, Michael, Ph.D., Associate Professor
Herrnkind, William F., Ph.D., Assistant Professor
Homann, Peter H., Ph.D., Assistant Professor
Livingston, Robert J., Ph.D., Assistant Professor
Mariscal, Richard, Ph.D., Assistant Professor
Short, Robert, Ph.D., Professor
Simberloff, Daniel, Ph.D., Assistant Professor
Stasek, Charles R., Ph.D., Associate Professor
Taylor, Herbert, Ph.D., Professor

DEPARTMENT OF ECONOMICS

Colberg, Marshall R., Ph.D., Professor

DEPARTMENT OF GEOGRAPHY

Chase, Harrison V., M.A., Associate Professor

DEPARTMENT OF GEOLOGY

Frakes, Lawrence A., Ph.D., Associate Professor
Tanner, William F., Ph.D., Professor
Tolstoy, Ivan, Ph.D., Professor

DEPARTMENT OF MATHEMATICS

Lau, Joseph P., Ph.D., Assistant Professor

DEPARTMENT OF METEOROLOGY

Barcilon, Albert, Ph.D., Assistant Professor
Fowlis, William W., Ph.D., Assistant Professor
O'Brien, James J., Ph.D., Associate Professor

DEPARTMENT OF OCEANOGRAPHY

Ashby, Ebert A., Ph.D., Associate Professor
Calder, John A., Ph.D., Assistant Professor
Garstang, Michael, Ph.D., Associate Professor
Glooschenko, Walter A., Ph.D., Assistant Professor (on leave)
Hadlock, Ronald K., Ph.D., Assistant Professor
Harriss, Robert C., Ph.D., Associate Professor
Hsueh, Ya, Ph.D., Assistant Professor
Jones, James I., Ph.D., Associate Professor
Krishnamurti, Ruby E., Ph.D., Assistant Professor
Kritzler, Henry, Ph.D., Professor
LaRock, Paul A., Ph.D., Assistant Professor
Menzel, R. Winston, Ph.D., Associate Professor
Menzies, Robert J., Ph.D., Professor
Staley, Raymond C., Ph.D., Associate Professor
Warnke, Detlef A., Ph.D., Assistant Professor
Warsh, Kenneth L., Ph.D., Assistant Professor
Winchester, John W., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Professor John W. Winchester
Chairman, Department of Oceanography
Florida State University
Tallahassee, Florida 32306

## UNIVERSITY OF FLORIDA
GAINESVILLE, FLORDIA

In 1964, the Division of Biological Sciences was created to provide interdisciplinary coordination among the life science disciplines and the Marine Sciences Section. Participating departments are Botany, Microbiology, Zoology, and Biochemistry. Research and teaching responsibility of the Division are carried out through the participating departments, most of whom will eventually be housed, entirely or in part, in the biological science building complex currently under construction. Two of the new buildings contain underground tanks for the storage of fresh sea water and marine aquaria rooms. In addition to the on-campus facilities the Division of Biological Sciences operates a Marine Biology Laboratory near Cedar Key and is preparing for a major expansion of marine oriented research at the new marine sciences institute at Marineland, Florida.

The Sea Horse Key Marine Laboratory is located 57 miles west of Gainesville on the Gulf Coast, three miles offshore, opposite Cedar Key. Living accommodations are provided in a ten room lighthouse, and a 20 x 40 foot laboratory building, complete with running sea water, is available for research use. The marine laboratory owns a 32-foot research vessel equipped for offshore work and a number of smaller boats for inshore and shallow water use. A dock and marine railway are situated next to the laboratory. The location at Sea Horse Key provides ease of access to diverse habitats ranging from freshwater rivers, estuaries and salt marshes to the marine water of the Gulf of Mexico. Clark Island and surrounding waters, amounting to 41 acres, located near Sea Horse Key, belong to the University of Florida. This undisturbed area is available for use in intensive studies of estuarine resources and processes.

The University of Florida's marine activities on the east coast of Florida have largely been centered at Marineland, Inc. in Flagler County. Through the courtesy of Marineland, the unique marine research

facilities have been made available to investigators from the University and have been extensively utilized by Biological Sciences, the College of Medicine and the Communication Sciences Laboratory. This cooperative arrangement recently resulted in an offer, accepted by the University, to construct a marine institute for use by the University of Florida.

In the Department of Geography, research competency includes fluvial and coastal geomorphology, water recreation, competitive demands for water resources, and the distribution and economics of fishing.

The Department of Geology has long had an active program in coastal and estuarine research and observation and research takes place in hydrogeology, geochemistry, sedimentation, stratigraphy, coastal processes, paleoecology, and submarine geology. Well-equipped laboratories for paleontological, sedimentological, mineralogic, petrographic, and geochemical studies are available.

The College of Pharmacy has recently begun an extensive program in Marine Biochemistry. The College has the facilities to examine a large number of marine specimens and to isolate and identify chemical substances present in these specimens and further to identify the potential pharmacological properties of these chemical substances.

The following degrees are offered:

1. Department of Botany: B.S., M.S., Ph.D.
2. Department of Zoology: B.S., M.S., Ph.D.
3. Department of Microbiology: M.S., Ph.D.
4. Department of Biochemistry: Ph.D.
5. Department of Geography: B.A., B.S., M.A., M.S., Ph.D.
6. Department of Geology: B.S., M.S.
7. College of Pharmacy: B.S., M.S., Ph.D., with majors in Pharmacology, Pharmacognosy, Pharmaceutical Chemistry.

The following courses are offered in conjunction with the above proprams:

BOTANY

| | |
|---|---|
| BTY 521 | Introductory Mycology |
| BTY 522 | Phycology |
| BTY 602 | Ecology of Aquatic Plants |
| BTY 621 | Advanced Mycology I |
| BTY 622 | Advanced Mycology II |
| BTY 623 | Advanced Mycology III |

GEOGRAPHY

| | |
|---|---|
| GPY 635 | Land and Water Utilization |

GEOLOGY

| | |
|---|---|
| GY 470 | Introduction to Oceanography |
| GY 508 | Geochemistry |
| GY 517 | Submarine Geology |
| GY 611 | Mineralogy of Clays |
| GY 690 | Special Topics in Geology |
| GY 6XX | Coastal and Estuarine Geology |
| GY 6XX | Physical Oceanography |

ZOOLOGY

| | |
|---|---|
| ZY 308 | Invertebrate Zoology |
| ZY 505 | General Ecology |
| ZY 579 | The Biology of Marine Animals |
| ZY 612 | Marine Ecology |
| ZY 625 | Protozoology |
| ZY 632 | Advanced Invertebrate Zoology |
| ZY 628 | Limnology |
| ZY 629 | Seminar in Ecology |
| ZY 651 | Ichthyology |

The University also offers undergraduate and graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DIVISION OF BIOLOGICAL SCIENCES

DEPARTMENT OF BOTANY

Aldrich, Henry C.
Anthony, David S.
Davis, Joseph S.
Ford, Ernest S.
Fritz, George J.
Griffin, Dana G.
Griffith, Mildred M.
Humphreys, Thomas E.
Kimborough, James W.
Lugo, Ariel
Mullins, J. Thomas
Rife, David C.
Shanor, Leland - Chairman
Smith, Richard G.
Vesil, Indra K.
Ward, Daniel B.
Stanley, Robert G.

DEPARTMENT OF ZOOLOGY

Anderson, John F.
Brodkorb, Pierce
Brookbank, John W.
Campbell, Howard
Carr, Archie F.
Carr, William
DeWitt, Richard M. - Chairman
Dinsmore, James J.
Emmel, Thomas C.
Elliott, Paul R.
Giesel, James T.
Goin, Coleman J.
Gregg, James H.
Johnson, F.C.
Johnston, David W.
Jones, E. R.
Kaufmann, John H.
Kilby, John D.
Laessle, Albert M.
Lanciani, C.A.
Leavitt, B.B.
McNab, Brian K.
Nordlie, Frank G.
Prange, Henry D.
Reiskind, Jonathan
Roye, David
Telford, Sam R.
Wallace, Howard K.
Wallbrunn, Henry M.
Westfall, Minter J.
Zam, Stephen C.
Auffenberg, Walter
Austin, Oliver Luther, Jr.
Berner, Lewis
Confer, John L.
Dickinson, Joshua Clifton, Jr.
Elliott, Paul Russell
Gilbert, Carter Rowell
Maslin, Paul E.
Maturo, Frank J. S., Jr.
Nation, James Lamar
Patton, Thomas H.
Pierce, Emory Lowe

Webb, Sawney David

DEPARTMENT OF MICROBIOLOGY

Bleiweis, Arnold A.
Bordeaux, Francis M.
Duggan, Dennis E.
Milan, James R.
Nasser, DeLill S.
Preston, James F.
Previc, Edward
Smith, Paul H.
Tyler, Max E. - Chairman
Chynoweth, Davis P.
Hoffman, Edward M.
Jefferies, Mildred B.
Schneider, Nathan J.
Smith, Kenneth L.

DEPARTMENT OF BIOCHEMISTRY

Allen, Charles M.
Cerutti, Peter A.
Chun, Paul W.
Fisher, Waldo R.
Fried, Melvin
Gurin, Samuel
Hoffman, Edward M.
Newcomb, Thomas F.
O'Brien, Thomas
Rennert, Owen M.
Roberts, R. Michael
Sander, Eugene G.
Stein, Abraham M.

THE COLLEGE OF ARTS AND SCIENCES

DEPARTMENT OF GEOGRAPHY

Anderson, James Richard
Crist, Raymond E.
Cross, Clark Irwin
Dickinson, Joshua Clifton
Dunke, John Robert
Lewis, P. W.
Marcus, Robert Brown
Mather, C. E.
McCune, Shannon
Niddrie, David Lawrence
Paganini, Louis Anthony

DEPARTMENT OF GEOLOGY

Blanchard, Frank Nelson
Brooks, Harold Kelly
Edwards, Richard Archer
Miffin, Martin David
Nicol, David
Pierce, Robert William, Jr.
Pirkle, Earl C., Jr.
Randazzo, Anthony Frank
Rappenecker, Caspar
Sutherland, Berry
Wahl, F. Michael
Webb, Sawney David

THE COLLEGE OF PHARMACY

Becker, Charles Henry
Angorn, Richard Arthur
Araujo, Oscar Eduardo
Blythe, Rudolph H.
Garrett, Edward Robert
Haupt, Charles S.
Lantos, Robert L.
Nackman, Lee Martin
Sisson, N. Mack
Torosian, George

To obtain further information, address all inquiries directly to:

Director
Center for Aquatic Sciences
University of Florida
Gainesville, Florida 32601

## FORDHAM UNIVERSITY
### BRONX, NEW YORK

The facilities of the New York Ocean Science Laboratories, Inc., Montauk Point, Long Island, New York are available. Fordham University is a charter member and active participant in this new research and teaching facility.

The following degrees are offered:

1. Ph.D. in Biological Sciences. The candidate must complete a program of study and research as recommended by his sponsor and approved by the Chairman. Before admission to candidacy, the student must pass a qualifying examination. Graduate credits will be granted only for courses passed with at least a "B". A course in which a student receives a "C" may be repeated with the permission of the Chairman after consultation with the course instructor. The candidate must prepare a dissertation acceptable for publication by a recognized journal in biology or a related field. When this dissertation has been accepted, the candidate must pass an oral examination on the subject matter of his research.

2. M.S. The candidate must complete 24 credits and submit a dissertation or complete 30 credits without a dissertation. The student must have a reading knowledge of French, German or Russian. With the Chairman's permission, students may substitute the computer language course for the language requirement. All candidates must take the comprehensive examination.

3. M.S. Summer Program. Offered by the Department is arranged so that all credits necessary to obtain the degree may be taken during three summer sessions. Those who wish to take advantage of this program must obtain approval from the Chairman, meet the requirements for entrance to the regular M.S. program and fulfill departmental requirements for the M.S. given above. The language examinations are usually given during the summer, and comprehensive examinations are given at the end of August. With the Chairman's approval, students may transfer from the summer program to the regular program, and vice versa.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| BIO 201 | Protistology | 5 |
| BIO 217 | Biology of Marine and Freshwater Microorganisms | 5 |
| BIO 218 | Biology of Marine and Freshwater Microorganisms | 5 |
| BIO 221 | Principles of Ecology | 2 |
| BIO 221S | Principles of Ecology | 2 |
| BIO 228 | Insect Behavior and Ecology | 5 |
| BIO 229 | Biological Evolution | 3 |
| BIO 312 | Biological and Chemical Oceanology | 5 |
| BIO 317 | Marine Zootoxicology | 3 |
| BIO 345 | Physiology of Biologically Active Compounds | 3 |
| BIO 382 | Protozoan Physiology | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGICAL SCIENCES

Aiello, Edward, Ph.D., Associate Professor
Alexander, James E., Ph.D., Associate Professor
Bistis, George N., Ph.D., Associate Professor
Forbes, James, Ph.D., Professor
Kevin, Monica, Sr., Ph.D., Assistant Professor
McLaughlin, John J. A., Ph.D., Chairman and Professor
Rauch, Nancy, Ph.D., Assistant Professor
Ruggieri, George, Fr., Ph.D., Adjunct Associate Professor
Sullivan, Daniel J., Fr., Ph.D., Assistant Professor
Witkus, Eleanor R., Ph.D., Professor
Zahl, Paul A., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dean, Graduate School of Arts and Sciences
Fordham University
Bronx, New York 10458

## THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, D.C.

The University offers marine science courses at its main campus in downtown Washington, D.C. and at a number of off-campus facilities within easy reach of the University.

The Bachelor of Science Degree in Oceanography is offered by and under the jurisdiction of the Columbian College, the liberal arts college of the University, and is administered by the College of General Studies. All students are required to satisfy many of the undergraduate requirements for the Bachelor of Science Degree. In addition specialization in oceanography is obtained by taking 21 hours in oceanography and additional work in geology, geophysics, biology and physics. The students take the professional courses in oceanography at the off-campus facilities. The balance are taken on-campus by full time students; these students participate in all normal University activities.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| OCEA 11 | Navigation | 3 |
| OCEA 101 | Elementary Oceanography | 3 |
| OCEA 102 | Elementary Oceanography | 3 |
| OCEA 110 | Ocean Dynamics | 3 |
| OCEA 111 | Ocean Waves and Tides | 3 |
| OCEA 112 | Biological Oceanography | 3 |
| OCEA 113 | Marine Geophysics | 3 |
| OCEA 114 | Chemical Oceanography | 3 |
| OCEA 115 | Geological Oceanography | 3 |
| GEOP 105 | Elementary Geophysics | 3 |
| GEOP 106 | Interpretation Theory - Geophysics | 3 |
| GEOP 115 | Elementary Seismology | 3 |
| CART 107 | Physiography | 3 |
| CART 108 | Climatology | 3 |

The instructional staff for the courses listed above consists of the following:

Algermissen, Sylvester T., Ph.D., Associate Professorial Lecturer
Andersen, Neil R., Ph.D., Assistant Professorial Lecturer
Buzas, Martin A., Ph.D., Associate Professorial Lecturer
Espinosa, Alvaro F., M.S., Assistant Professorial Lecturer
Hicks, Steacy D., M.S., Associate Professorial Lecturer
Long, Edward, M.S., Lecturer
Morrison, Robert E., Ph.D., Associate Professorial Lecturer
Orlin, Hyman, Ph.D., Program Adviser and Professorial Lecturer
Rinehart, Wilbur A., M.S., Lecturer
Rucker, James B., Ph.D., Professorial Lecturer
Vogt, Peter, Ph.D., Lecturer

To obtain further information, address all inquiries directly to:

Director of Credit Programs
College of General Studies
The George Washington University
706 20th Street, N.W.
Washington, D.C. 20006

## UNIVERSITY OF GEORGIA
ATHENS, GEORGIA

Modern graduate training and research facilities in marine sciences are available on the Athens campus and at the University's Marine Institute on Sapelo Island, Georgia. In addition, staff and graduate students participate in studies utilizing federally supported ships and other facilities not owned by the University.

Facilities for training and research in the marine sciences at Athens include classrooms and laboratories in all participating departments. At Sapelo Island, modern, well-equipped laboratories occupy more than 10,000 square feet of space. Living accommodations on the Island include family housing units for staff and dormitory space for 18. The principal research vessel of the Institute is 65 feet in length and is equipped to carry out investigations on the continental shelf and slope as well as in the estuaries. A fleet of smaller boats is maintained for work in the extensive estuaries and salt marshes of the area. Research at the Institute has centered mainly in the ecology of marshes and estuaries, aquaculture, estuarine pollution, the geochemistry of estuaries and shelf waters, and the geology of the barrier islands and Pleistocene shelf deposits.

The University offers the M.S. and Ph.D. degrees with emphasis on marine science in four basic science departments; Botany, Geology, Microbiology, and Zoology. No degrees specifically designated as marine science or oceanography are offered. Specific degree requirements vary slightly among the departments, but, in general, 40 credit hours of formal course work, a thesis and a reading knowledge of one foreign language, as well as satisfactory performance on a comprehensive examination in the basic science field involved, are required for the M.S. degree. Formal course requirements for the Ph.D. are flexible, the program being determined by the student in consulation with his advisory committee. Preliminary written and oral examinations and a final oral examination are administered by the department. A dissertation and in some departments, a reading know-

ledge of a second foreign language are also required for the Ph.D.

Courses pertinent to graduate training in the biological and physical aspects of marine sciences are offered in the Division of Physical Sciences and Division of Biological Sciences in the College of Arts and Sciences and in the School of Forest Resources. In the College of Arts and Sciences the departments which grant graduate degrees with marine science specialization are: Botany, Microbiology, Zoology, and Geology.

Advanced courses that are wholly or partly marine in aspect are listed by department. Courses number 800 or above are strictly graduate, others are senior-graduate. All are based on the Athens campus but may involve trips to the field and to other facilities. Credits are in quarter hours.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BOTANY

| | | |
|---|---|---|
| 610 | Growth and Development of Algae | 5 |
| 611 | Biochemistry of Algae | |
| 860 | Aquatic Plants | 5 |

SCHOOL OF FOREST RESOURCES

| | | |
|---|---|---|
| 767 | Marine Fisheries | 5 |

DEPARTMENT OF GEOGRAPHY

| | | |
|---|---|---|
| 601 | Advanced Climatology | 5 |
| 602 | North American Physiography | 5 |
| 620 | Use and Interpretation of Aerial Photographs | 5 |
| 622 | Advanced Photogrammetry Laboratory | 5 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 603 | Invertebrate Paleontology | 5 |
| 605 | Sedimentation and Stratigraphy | 5 |
| 608 | Optical Mineralogy | 5 |
| 609 | Marine Geology | 5 |
| 610 | Sedimentary Petrology | 3 |
| 611 | Principles of Geochemistry | 3 |
| 612 | Palynology | 5 |
| 613 | Paleobotany | 5 |
| 630 | Clay Mineralogy | 5 |
| 639 | Introduction to Geophysics | 5 |
| 805 | Advanced Stratigraphy | 3 |
| 811 | Petrography and Petrology of Sedimentary Rocks | 3 |
| 815 | Special Problems in Sedimentology and Oceanography | 5 |
| 820 | Geotectonics | 3 |

DEPARTMENT OF MICROBIOLOGY

| | | |
|---|---|---|
| 662 | Aspects of Microbial Ecology | 5 |
| 860 | Physiology of Bacteria | 5 |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| 605 | Ichthyology | 5 |
| 660 | Marine Ecology | 5 |
| 800 | Bioenergetics and Ecosystems | 5 |
| 807 | Advanced Invertebrate Zoology | 5 |
| 808 | Advanced Invertebrate Zoology | 5 |
| 810 | Limnology and Oceanography | 5 |
| 811 | Marine Biology | 5 |
| 812 | Freshwater Biology | 5 |
| 813 | Hydrobiology Seminar | 1 |
| 854 | Physiological Ecology | 5 |
| 855 | Population Ecology | 5 |
| 856 | Ecology Seminar | 1 |
| 857 | Pollution Ecology | 5 |
| 858 | Systems Ecology I | 3 |
| 859 | Systems Ecology II | 3 |
| 868 | Systems Ecology Dynamic Analysis I | 5 |
| 869 | Systems Ecology Dynamic Analysis II | 5 |

The instructional staff for the courses listed above consists of the following:

UNIVERSITY OF GEORGIA MARINE INSTITUTE

Greene, Albert G., Ph.D., Assistant Director
Henry, Vernon J., Ph.D., Director and Associate Professor of Geology
Howard, James D., Ph.D., Assistant Professor of Geology
Marland, Frederick C., Ph.D., Research Associate in Zoology
Reimold, Robert J., Ph.D., Assistant Professor of Zoology

DEPARTMENT OF BOTANY

Darley, W. Marshall, Ph.D., Assistant Professor of Botany
Fuller, Melvin S., Ph.D., Head and Professor of Botany
Duncan, Wilbur H., Ph.D., Professor of Botany
Kochert, Gary, Ph.D., Assistant Professor of Botany
Porter, David, Ph.D., Assistant Professor of Botany

SCHOOL OF FOREST RESOURCES

Huish, Melvin T., Ph.D., Assistant Professor of Fisheries
Fox, Alfred C., Ph.D., Unit Leader, Cooperative Fishery Unit, USFWS and Assistant Professor of Fisheries

DEPARTMENT OF GEOLOGY

Allard, Gilles O., Ph.D., Professor of Geology
Blount, C. W., Assistant Professor of Geology
Brown, Anton, Ph.D., Assistant Professor of Geology
Carver, Robert E., Ph.D., Assistant Professor of Geology
Frey, Robert W., Ph.D., Assistant Professor of Geology
Herz, Norman, Ph.D., Head and Professor of Geology
Hurst, Vernon J., Ph.D., Professor of Geology
Margolis, Stanley V., Ph.D., Assistant Professor of Geology
Noakes, John E., Ph.D., Associate Professor of Geology
Rich, Mark, Ph.D., Professor of Geology
Sen Gupta, Barun, Ph.D., Assistant Professor of Geology
Stanley, Edward A., Ph.D., Associate Professor of Geology
Voorhies, Michael R., Ph.D., Assistant Professor of Geology

DEPARTMENT OF MICROBIOLOGY

Eagon, Robert G., Ph.D., Professor of Microbiology
Finnerty, William R., Ph.D., Associate Professor of Microbiology
Guarraia, Leonard J., Ph.D., Assistant

Professor of Microbiology
Payne, William J., Ph.D., Head and Professor of Microbiology
Wiebe, William J., Ph.D., Assistant Professor of Microbiology

DEPARTMENT OF ZOOLOGY

Cosgrove, William B., Ph.D., Head and Alumni Foundation Distinguished Professor of Zoology
Frankenberg, Dirk, Ph.D., Associate Professor of Zoology
Johannes, Robert E., Ph.D., Associate Professor of Zoology
Odum, Eugene P., Ph.D., Alumni Foundation Distinguished Professor of Zoology
Patten, Bernard C., Ph.D., Professor of Zoology
Pomeroy, Lawrence R., Ph.D., Professor of Zoology
Scott, Donald C., Ph.D., Chairman, Division of Biological Sciences and Professor of Zoology
Thomas, Grace J., Ph.D., Associate Professor of Zoology

To obtain further information, address all inquiries directly to:

Dean of the Graduate School
University of Georgia
Athens, Georgia 30601

## UNIVERSITY OF GUAM
AGANA, GUAM

The University's marine facilities are located both on the campus and at the Marine Laboratory. The 25,000 square-foot Science Building holds the classrooms and offices of the Department of Biology. The Marine Laboratory, located on a low bluff adjacent to the campus, contains office and research laboratory space for the marine-related activities. Fourteen, 18, and 20-foot boats are available for offshore and outside-the-reef studies. Major sea-water analytical equipment is available. The University publishes the journal "Micronesica" devoted to the natural sciences of Micronesia and related areas. It is currently in its seventh volume.

The University offers the degree of M.S. in Biology. Although this M.S. degree in biology is not specifically designed as a marine science-oriented program, the majority of students at the University work with some aspect of marine studies. Students may elect either the 30 credit-hour-thesis program or the 36 credit-hour-nonthesis program. Special problems or directed research are also allowed.

The following courses are offered in conjunction with the above program:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 310 | Oceanology | 3 |
| 440 | Ichthyology | 4 |
| 510 | Marine Biogeography | 2 |
| 511 | Marine Ecology | 4 |
| 513 | Marine Microbiology | 4 |
| 535 | Topics in Invertebrate Physiology | 4 |
| 546 | Marine Invertebrates | 4 |
| 574 | Marine Botany | 4 |
| 695 | Thesis Research | 6 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Cheney, D. P., Ph.D., Assistant Professor of Biology
Eldredge, L. G., Ph.D., Chairman and Professor of Biology
Jones, R. S., Ph.D., Professor of Biology
Marsh, J. A., Ph.D., Assistant Professor of Biology
Randall, R. H., M.S., Instructor of Biology
Tsuda, R. T., Ph.D., Associate Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. R. S. Jones
Director, Marine Laboratory
University of Guam
Agana, Guam 96910

Dr. L. G. Eldredge
Chairman, Department of Biology
University of Guam
Agana, Guam 96910

## HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS

The University offers oceanography courses relating to marine biology at the main campus in Cambridge. Additional facilities are available for study in Oceanography at the Woods Hole Oceanographic Institution at Woods Hole, Mass. Cross registration of Harvard and Woods Hole graduate students in biological oceanography allows students access to facilities such as the fleet of research vessels and staff members experienced in techniques of work at sea. Other oceanographic facilities and courses are available through Massachusetts Institute of Technology, the Marine Biological Laboratory, Bermuda Biological Station for Research, Massachusetts Department of Conservation (Division of Marine Fisheries) and U.S. Fish and Wildlife Service. Laboratory facilities are maintained at the Biological Laboratories on the Cambridge campus. Study collections are available in the botanical, zoological and geological museums and the Museum of Comparative Zoology. Library facilities are maintained at the Biological Laboratories and at the general libraries on campus.

The extensive facilities of the Harvard Engineering and Physics Laboratories, the Computer Center, and the Electronics Design Center are available for research related to oceanography. In addition, oceanographic research may be carried out in the Center for Earth and Planetary Physics which consists of a group of faculty with common interest in the application of physical and mathematical methods to the investigation of the earth and solar system.

Because the study of the ocean employs many basic disciplines, Harvard maintains that the biological oceanographer should be thoroughly qualified in the classical scientific discipline of biology. The student's study of the biology of the ocean should proceed as a specialty within biology. Therefore, there is no department

of oceanography at Harvard. Rather, students will be prepared for the study of biological oceanography by members of the Biology Department. The courses offered at Harvard are sufficiently varied to prepare students for work in almost all aspects of oceanography.

The following degrees are offered:

1. Ph.D. in Biology. A beginning student will be assigned an advisor in the Department of Biology who will arrange for him to meet with a Prescription Committee to determine what courses are appropriate for his particular specialty. When ready to begin the Ph.D. thesis program, the student will seek a sponsor to provide guidance thereafter. A reading knowledge of one modern foreign language commonly encountered in biology literature is required. Students should acquire further experience through summer study or employment at marine laboratories or on research vessels whenever possible.

2. A.M. in Biology. Graduate students in the Department of Biology must all be candidates for the Ph.D. degree. They may, however, apply for the A.M. degree when they have completed 8 half courses with honor grades and given evidence of reading knowledge of one modern foreign language. Only courses above elementary grade are acceptable for this purpose. At least one course must include original investigation under the guidance of a member of the Department of Biology or associated institutions.

Those interested in physical oceanography may enroll in Ph.D. programs in Physics, Applied Physics or Mathematics. Graduate students will ordinarily meet the requirements for higher degrees within one of these existing divisions of the faculty (normally consisting of course work, a qualifying examination, and an original thesis). If their programs necessarily bridge two or more established departments, their degrees may be administered by a joint committee composed of members of the departments concerned.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| Bio 121 | Biology of Marine Invertebrates | |
| Bio 122 | Biology of the Sea Floor | |
| Bio 130 | Biology of Fishes | |
| Bio 143 | Principles of Ecology | |
| Bio 233 | Malacology | |
| Bio 243 | Biological Oceanography | |
| Bio 246 | Biogeography of Animals | |
| Bio 251 | Topics in Theoretical Population Biology | |
| Bio 253 | Population and Communities | |
| Bio 334 | Invertebrate Zoology and Marine Biogeography | |
| Bio 343 | Ecology and Oceanography | |
| Bio 345 | Biological Oceanography | |
| Eng 234 | Dynamics and Wave Motion | 3 |
| Eng 273b | Environmental Microbiology | |
| N.S. 28 | Prediction and Control of Atmospheres and Oceans | 3 |
| Phys 102 | Introduction to Physical Oceanography | 3 |
| Phys 201 | Dynamics | 3 |
| Phys 203 | Energy Transfer | 3 |
| Phys 212 | Special Topics in Geophysical Fluid Dynamics | 3 |
| Phys 216 | Physical Oceanography | 3 |

The instructional staff for the courses listed above consists of the following:

COMMITTEE ON OCEANOGRAPHY

Birch, Francis, Professor of Geology
Carrier, George F., Professor of Mechanical Engineering
Clarke, George L., Professor of Biology
Goody, Richard M., Professor of Planetary Physics
Revelle, Roger R., Professor of Population Policy (Public Health)
Robinson, A. R., Professor of Geophysical Fluid Dynamics
Siever, Raymond, Professor of Geology
Wilson, E. Bright, Jr., Professor of Chemistry

DEPARTMENT OF BIOLOGY

Boss, Kenneth J., Professor of Biology
Clarke, George L., Professor of Biology
Fell, Howard B., Professor of Invertebrate Zoology
Gadgil, Madhav, Lecturer on Biology
Ketchum, Bostwick H., Associate member
Myers, George S., Visiting Professor of Ichthyology
Roberts, Tyson R., Lecturer on Biology
Turner, Ruth D., Lecturer on Biology

DIVISION OF ENGINEERING AND APPLIED PHYSICS

Baker, D. J., Jr., Associate Professor of Physical Oceanography
Carrier, G. F., Gordon McKay Professor of Mechanical Engineering
Goody, R. M., Mallinckrodt Professor of Planetary Physics
Fofonoff, N. P., Gordon McKay Professor of the Practice of Physical Oceanography
Robinson, A. R., Gordon McKay Professor of Geophysical Fluid Dynamics
Stone, P. H., Associate Professor of Dynamic Meteorology

To obtain further information, address all inquiries directly to:

George F. Carrier
Division of Engineering and Applied Physics
Harvard University
Cambridge, Massachusetts 02138

## UNIVERSITY OF HAWAII
### HONOLULU, HAWAII

A wide spectrum of curricula in the marine sciences and related fields are available at the University of Hawaii. Graduate level marine related curricula are offered in the Department of Oceanography, Zoology, Botany, Microbiology, Geosciences, Psychology and Architecture in the College of Arts and Sciences; the Department of Physiology in the School of Medicine; the Department of Agricultural Economics in the College of Tropical Agriculture; and other opportunities for associated study exist at the Hawaii Institute of Geophysics, the Hawaii Institute of Marine Biology, The Pacific Biomedical Research Institute, the Center for Engineering Research, the Water Resources Research Center, and the Environmental Research Center.

Degrees in Oceanography or other strictly marine related disciplines are not offered

on the undergraduate level. Mechanisms and opportunities for acquiring a marine orientation are, however, available for undergraduates in any curriculum. These include opportunities for acquisition of marine skills, approximately fifty undergraduate courses in specific disciplines having a marine orientation and a smaller number of interdisciplinary courses.

Available facilities include the Marine Laboratory of the Institute of Marine Biology, with facilities for on site investigation of marine biologies in a reef, bay or open ocean environment. This Laboratory is located on an island in Kaneohe Bay in Oahu. The Department of Oceanography and the Hawaii Institute of Geophysics are located on the Manoa Campus and have available a computing center and associated research facilities. Two research ships are operated for these departments. Currently these consist of the 180-foot oceanographic ship MAHI and the 90-foot research ship TERITU. Both of these ships are due to be replaced in the next few months. Berthing and outfitting facilities are available at Pier 18 on Oahu.

The Look Laboratory of Ocean Research has facilities for modeling coastal environments and for limited hyperbaric manned and unmanned experiments. Its location in Kewalo Basin permits immediate access to ocean environment. The Pacific Biomedical Research Institute is located at the same site and provides facilities for research with marine mammals and with humans in hyperbaric atmospheres. The Cloud Physics Laboratory is maintained on the Island of Hawaii. Numerous other on site facilities are available in connection with the programs of specific departments.

Opportunities for cooperative programs exist with the National Oceanographic and Atmospheric Administration, the Oceanic Foundation, and the Naval Underseas Center, Kaneohe Bay. These institutions have extensive marine facilities including vessels, ships, submersibles, hyperbaric habitats, mammal testing and training facilities, etc.

The University has an extensive Sea Grant Program which provides opportunities for support of graduate study in the various marine oriented departments. Examining marine resources and learning to use them frequently requires expertise from several of the established disciplines. The Sea Grant Program expressly encourages innovative interdisciplinary research and the development of courses to more adequately encompass the relevant dimensions of marine problems.

The following degrees are offered:

1. Department of Oceanography - Intended candidates should have a major in physics, chemistry, geology, geophysics, engineering, mathematics, biology, zoology, or botany. A minimum of one year of calculus, physics and chemistry is required of all students prior to admittance. Depending upon the specific areas of interest undergraduate deficiencies, if any, are determined by the faculty. Graduate Record Examinations (Advanced and Aptitude) are required. Interested students should write to the department chairman for a brochure and further information.

The student's first year is generally devoted to removing deficiencies and completing the four basic oceanography courses. Subsequently the student specializes depending on his disciplinary inclinations. Students pursuing a degree program must take the following courses or their equivalents: Ocn 620; 621; 622; 623.

The M.S. program requires a minimum total of 30 credit hours; including 18 credits of course work and 12 credits of thesis research. The student is also required to take an oceanography seminar course and must show qualification in computer technology. A candidate for the Ph.D. must pass a qualifying examination, a comprehensive examination and a final oral examination in defense of his dissertation. He must also qualify in one foreign language and computer technology.

2. Department of Zoology - Intended candidates for the M.S. or Ph.D. in zoology must present a minimum of 18 hours of undergraduate preparation in zoology, including courses in vertebrate zoology (including comparative anatomy), embryology, and physiology. M.S. and Ph.D. candidates should have completed two years of chemistry (inorganic and organic), and courses in calculus, botany, and one year of physics. Deficiencies in undergraduate preparation must be made up. An official record of the student's performance on the Graduate Record Examination (Aptitude Test and the Advanced Test in Biology) must be submitted to the chairman of the zoology department before any action will be taken on applications for admission.

One seminar each year is required. Zoology 702 and 800 are required only for Ph.D. candidates. For the M.S. under Plan A a maximum of 6 hours, and under Plan B a minimum of 6 hours, may be elected from related courses in botany, chemistry, entomology, genetics, mathematics, meteorology, oceanography, and physics. For the Ph.D., additional work will be stipulated by the supervising committee. Ph.D. candidates must pass a reading examination in one foreign language.

3. Department of Botany - Intended candidates for either the M.S. or Ph.D. degrees must present a minimum of 18 hours of undergraduate credit in botany or related subjects such as microbiology, developmental biology, genetics or biochemistry. Additional work required to remedy deficiencies and for degree programs will be decided through a diagnostic examination at the time of enrollment in the department and by continuing faculty counseling. Thesis work may be undertaken in four broad areas: environmental botany; physiology and biochemistry; structure and development; and systematics and evolution. Appropriate organisms for research may be selected from the algae, fungi, ferns, or flowering plants, representing tropical, marine or economic plants.

4. Department of Microbiology - The Department of Microbiology offers three undergraduate courses in Microbiology. Biology 220 and 250 are required of all students majoring in Microbiology, Microbiology 351 being a prerequisite to all more advanced courses.

The Department offers programs leading to the M.S. and Ph.D. in microbiology with areas of specialization in microbial biochemistry, genetics, and ultrastructure; the biology of infectious diseases; the biochemistry and genetics of viruses; im-

munology and immunochemistry; marine microbiology; developmental and cell biology; and exobiology. Research programs in interdisciplinary fields are possible. Studies in microbiology emphasize fundamental cellular and molecular approaches rather than those primarily of an applied or diagnostic character.

Undergraduate preparation in both biological and physical sciences, including biology, genetics, microbiology, organic and physical chemistry, physics, and calculus is desirable, but deficiencies in some of these areas do not preclude admission. Qualified students with undergraduate majors in fields other than microbiology are welcomed. Ph.D. candidates are required to take an initial diagnostic examination and to demonstrate proficiency in one foreign language before graduation. Experience in teaching in a laboratory course is considered part of the training of the Ph.D. candidate. Official scores of the aptitude test and the advanced test in biology of the Graduate Record Examination and three letters of recommendation are required of all applicants.

5. Department of Geosciences - M.S. A minimum of 24 credit hours of course work and 6 credit hours of thesis research, as well as a reading knowledge of one foreign language with useful scientific literature in the field of the candidate. General and thesis examinations are required.

Ph.D. A reading comprehension of one foreign language with useful scientific literature in the field of the candidate.

Geodesy - Intended candidates should have a B.S. or B.A. degree with a major in one of the following fields: mathematics, physics, geodesy, geology, geophysics or civil engineering. Prior to entering the graduate program,the student should have taken the equivalent of University of Hawaii offerings in Civil Engineering III (Surveying), Civil Engineering 311 (Photogrammetry) and Geography 235 (Map and Airphoto Interpretation) or equivalent knowledge of those topics gained through practical experience. Deficiencies in undergraduate preparation must be made up. As a minimum requirement, he also should have one year of geology and be knowledgeable in general physics and mathematics through calculus. Graduate courses in photogrammetry available at the University of Washington, Seattle, under a co-operative program.

Geology - Intended candidates will be accepted from undergraduate majors in the natural sciences, mathematics, and engineering. Students not having year length courses in elementary geology, physics, chemistry, college mathematics, and geological field methods, and at least one semester of mineralogy petrology and stuctural geology or their equivalent will be obliged to take those courses. The M.S. general examination and the Ph.D. comprehensive examination may include questions from all of the basic fields of geology, such as mineralogy, petrology, structural geology, stratigraphy, geomorphology and paleontology.

Hydrology - Training in hydrology involves not only several fields of the geosciences but several other disciplines. Intended candidates will usually be accepted from undergraduate majors in the natural sciences or engineering. Students not having adequate backgrounds in geosciences, mathematics, physics, chemistry, or hydraulics may be required to take certain undergraduate courses.

Degree programs may be arranged which emphasize various aspects of hydrology. Such programs will involve not only courses from the geosciences but courses in geography, oceanography, engineering, soils, agriculture, or other fields, depending on the aspects to be emphasized. The Hawaiian environment offers special opportunities for research in tropical hydro-meteorology, tropical agrohydrology, and geohydrology of oceanic islands and basalt terraoms.

Meteorology - Intended candidates must present a thorough preparation in general physics, chemistry, and mathematics through calculus, as well as a minimum of 14 hours of undergraduate credit in meteorology including courses in climatology, instruments and observations, descriptive meteorology, and synoptic meteorology. Deficiencies in undergraduate preparation must be made up. Besides geosciences courses, courses may be allowed in the fields of oceanography, physics, and mathematics.

Solid Earth Geophysics - Intended candidates will be accepted from undergraduate majors in physical sciences, mathematics and engineering. Deficiencies in undergraduate preparation in mathematics, physics, chemistry or geology must be made up. The background required depends upon each candidate's choice of specialization. Besides geosciences courses, courses in physics, engineering, oceanography and mathematics may be included in the candidate's program.

6. Department of Psychology - Graduate courses and thesis opportunities are available in the Psychology Department in Animal Psychology and in particular in psychology of marine mammals.

7. Department of Architecture - Opportunities for independent research and projects in Oceanic Architecture are available particularly in environmental design and tropical studies.

8. Department of Physiology - The Department of Physiology offers advance course and thesis opportunities in the physiology of man and marine mammals.

9. Department of Agricultural Economics Selected courses and thesis opportunities are available in the economics of marine related agriculture, agriculture Mariculture.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF OCEANOGRAPHY

UNDERGRADUATE COURSE

| | | |
|---|---|---|
| 201 | Science of the Sea | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| 620 | Physical Oceanography | 3 |
| 621 | Biological Oceanography | 3 |
| 622 | Geological Oceanography | 3 |
| 623 | Chemical Oceanography | 3 |
| 630 | Physical Oceanography Laboratory | 1 |
| 632 | Littoral Geological Processes | 3 |
| 633 | Chemical Oceanography Laboratory Methods | 1 |
| 636 | Phytoplankton Ecology | 3 |
| 640 | Advanced Physical Oceanography | 3 |

| | | |
|---|---|---|
| 642 | Sedimentology | 3 |
| 643 | Marine Geochemistry | 3 |
| 644 | Marine Geophysics | 3 |
| 646 | Zooplankton Ecology | 2 |
| 647 | Zooplankton Ecology Laboratory | 2 |
| 650 | Mathematical Techniques for Biologists | 3 |
| 661 | Tides | 3 |
| 662 | Marine Hydrodynamics | 3 |
| 663 | Measurements and Instrumentation | 2 |
| 664 | Principles of Underwater Acoustics | 2 |
| 672 | Seminar in Geotechtonics | arr |
| 673 | Continental Shelves | 3 |
| 699 | Directed Research | arr |
| 701 | Nekton Ecology | 3 |
| 702 | Deep Sea Biology | 3 |
| 735 | Seminar in Oceanography | 2 |
| 750 | Topics in Biological Oceanography | 2 |
| 760 | Topics in Physical Oceanography | 2 |
| 770 | Seminar in Chemical Oceanography | 1 |
| 800 | Thesis Research | arr |

DEPARTMENT OF ZOOLOGY

GRADUATE COURSES

| | | |
|---|---|---|
| 101 | Principles of Zoology | 4 |
| 310 | Invertebrate Zoology | 3 |
| 320 | Vertebrate Zoology | 4 |
| 330 | Principles of Ecology | 2 |
| 430 | Animal Physiology | 3 |
| 435 | Endocrinology | 2 |
| 465 | General Ichthyology | 3 |
| 470 | Limnology | 3 |
| 480 | Animal Evolution | 2 |
| 490 | General Zoology Seminar | 1 |
| 493 | Senior Honors Thesis | 2 |
| 494 | Senior Honors Thesis | 2 |
| 499 | Directed Reading or Research | arr |
| 603 | Zoogeography | 2 |
| 605 | Comparative Endocrinology | 4 |
| 610 | Topics in Developmental Biology | arr |
| 620 | Marine Ecology | 3 |
| 646 | Comparative Ivertebrate Physiology | 3 |
| 666 | Advanced Ichthyology | 3 |
| 691 | Seminar in Zoology | 1 |
| 699 | Directed Research | arr |
| 702 | Preparation of Scientific Manuscripts | 1 |
| 714 | Topics in Animal Behavior | arr |
| 715 | Topics in Invertebrate Zoology | 3 |
| 716 | Topics in Fish and Fisheries Biology | 3 |
| 718 | Topics in Animal Physiology | 3 |
| 800 | Thesis Research | arr |

DEPARTMENT OF BOTANY

GRADUATE COURSES

| | | |
|---|---|---|
| 631 | Marine Phytoplankton | 3 |
| 651 | Dynamics of Marine Productivity | 3 |
| 699 | Directed Research | arr |
| 799 | Directed Research | arr |
| 800 | Thesis Research | arr |

DEPARTMENT OF MICROBIOLOGY

GRADUATE COURSES

| | | |
|---|---|---|
| 642 | Marine Microbiology | 3 |
| 690 | Seminar | 1 |
| 699 | Directed Research | arr |
| 795 | Special Topics | arr |
| 800 | Thesis Research | arr |

DEPARTMENT OF PHYSIOLOGY

GRADUATE COURSE

| | | |
|---|---|---|
| 607 | Physiological Adaptation to the Environment I | 2 |

DEPARTMENT OF AGRICULTURAL ECONOMICS

GRADUATE COURSES

| | | |
|---|---|---|
| 432 | Introduction to Natural Resource Economics I | 3 |
| 667 | Resource Economics II | 3 |

The University also offers graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF OCEANOGRAPHY

Andrews, J. E., Ph.D., Assistant Professor of Oceanography-geological
Barklev, R., Ph.D., Oceanography-physical
Brock, V. E., M.A., Professor of Oceanography-biological
Caperon, J., Ph.D., Associate Professor of Oceanography-biological
Cattell, Ph.D., Assistant Professor of Oceanography
Chave, K. E., Ph.D., Chairman and Professor of Oceanography-biological, chemical
Clarke, T. A., Ph.D., Assistant Professor of Oceanography-biological
Gallagher, B. S., Ph.D., Assistant Professor of Oceanography-physical
Gordon, Ph.D., Assistant Professor of Oceanography
Groves, G. W., Ph.D., Professor of Oceanography-physical
Hardy, W. A., Ph.D., Professor of Oceanography-physical
Malahoff, A., Ph.D., Associate Professor of Oceanography-geological
Murphy, G. I., Ph.D., Professor of Oceanography-biological
Roy, Ph.D., Assistant Professor of Oceanography
Seckel, C. R., M.S., Oceanography-physical
Stroup, E. D., Ph.D., Associate Professor of Oceanography-physical
Wyrtki, K., Ph.D., Professor of Oceanography-physical
Young, R. E., Ph.D., Assistant Professor of Oceanography-biological



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DEPARTMENT OF ZOOLOGY

Arnold, J. M., Ph.D., developmental biology
Bailey, J. H., Ph.D., invertebrate zoology
Banner, A. H., Ph.D., invertebrate zoology, systematics
Berger, A. J., Ph.D., Chairman and Professor of Zoology
Brock, V. E., M.A., fishery biology, oceanography
Gosline, W. A., Ph.D., ichthyology, zoogeography and evolution
Hadfield, M. G., Ph.D., developmental biology of invertebrates
Haley, S. R., Ph.D., invertebrate embryology
Helfrich, P., Ph.D., ichthyology, ecology
Kamemoto, F. I., Ph.D., physiology, endocrinology
Kay, E. A., Ph.D., malacology
Maciolek, J. A., Ph.D., limnology, fishery biology
Randall, J. E., Ph.D., ichthyology
Reed, S. A., Ph.D., coral physiology
Stevens, E. D., Ph.D., physiology
Tester, A. L., Ph.D., fishery biology, biometry
Townsley, S. J., Ph.D., invertebrate zoology, ecology, radio-biology
van Weel, P. B., Ph.D., physiology, physiological ecology

DEPARTMENT OF BOTANY

Doty, M. S., Ph.D., Professor of Botany-marine ecology
Kefford, N. P., Ph.D., Chairman and Professor of Botany

DEPARTMENT OF MICROBIOLOGY

Benedict, A. A., Ph.D., Chairman and Professor of Microbiology
Gundersen, K. R., Ph.D., Associate Professor of Microbiology-marine microbiology

DEPARTMENT OF PHYSIOLOGY

Hampton, I. F. G., Ph.D., Assistant Professor of Physiology-environmental physiology
Hong, S. K., M.D., Ph.D., Professor of Physiology-environmental and renal physiology
Moore, T. O., Ph.D., Assistant Professor of Physiology-environmental physiology
Rogers, T. A., Ph.D., Chairman and Professor of Physiology-environmental physiology

DEPARTMENT OF AGRICULTURAL ECONOMICS

Baker, H. L., Ph.D., resource economics
Gertel, K., Ph.D., resource economics
Gopalakrishnan, C., Ph.D., Associate Professor of Agricultural Economics-resource economics and marine economics
Spielmann, Heinz, Ph.D., Acting Chairman and Professor of Agricultural Economics-marketing and agricultural policy
Yamauchi, H., Ph.D., Assistant Professor of Agricultural Economics-resource economics

To obtain further information, address all inquiries directly to:

Dr. John P. Craven
Dean, Marine Programs
University of Hawaii
Honolulu, Hawaii 96822

## UNIVERSITY OF HOUSTON
HOUSTON, TEXAS

Modern research facilities, including wet labs and cold storage, are available on the main campus in the Departments of Geology, Biophysics and Biology. Supplementary facilities, including a marine laboratory and fish tank, have been developed at the University's Coastal Environment Field Station, comprising 1600 acres in the Galveston Bay Area south of Houston. Sea-going vessels are available in the Departments of Geology and Biology. (Additional facilities available in the Cullen College of Engineering, University of Houston, are described in the Ocean Engineering section of this publication.)

The Biology Department of the College of Arts and Sciences provides a graduate curriculum which allows a student to obtain a M.S. or Ph.D. in Biology specializing in one of the following areas of Marine Biology: (1) Ecology (2) Plant Science (3) Animal Physiology or (4) Microbiology. This program is experimentally oriented with the research programs emphasizing the estuaries and the waters of the continental shelf.

The Geology Department in the College of Arts and Sciences offers courses leading to a M.S. in Geology with emphasis on marine geology and exploration geophysics. Special programs can be arranged to combine geological oceanography with ocean engineering or other suitable curricula. The department does not have deep ocean facilities, but does work extensively throughout the nearshore marine and coastal environments.

A J.D. with emphasis in the marine field is offered by the Bates College of Law.

The following courses are offered in conjunction with the above programs:

BIOLOGY DEPARTMENT

| | |
|---|---|
| BIO 414A | Field Biology |
| BIO 414B | Field Biology |
| BIO 414C | Field Biology |
| BIO 426A | Ecological Methods |
| BIO 426B | Ecological Methods |
| BIO 436 | Ecology |
| BIO 443 | Comparative Animal Physiology |
| BIO 444 | Invertebrate Zoology |
| BIO 444A | Marine Biology |
| BIO 448 | Embryology |
| BIO 633 | Marine Plants |
| BIO 633A | Physiology of Marine Bacteria |
| BIO 683A | Physiology of Marine Animals |

GEOLOGY DEPARTMENT

| | |
|---|---|
| GEO 380 | Geology for Engineers |
| GEO 431 | Earth Physics |
| GEO 438 | Physical Oceanography |
| GEO 491 | General Oceanography |
| GEO 631 | Marine Geology |
| GEO 633 | Nearshore Processes and Problems |
| GEO 667 | Geochemistry I |
| GEO 668 | Geochemistry II |
| GEO 669 | Organic Geochemistry |
| GEO 680 | Advanced Sedimentation |
| GEO 682 | Sandstone Petrography |
| GEO 683 | Carbonate Petrography |

| | |
|---|---|
| GEO 690 | Quantitative Methods in Paleontology |
| GEO 691 | Micropaleontology I |
| GEO 692 | Biostratigraphy |
| GEO 693 | Micropaleontology II |
| GEO 694 | Paleoecology |
| GEO 696 | Stratigraphic Analysis |
| GEO 730 | Principles of Gravity and Magnetic Exploration |
| GEO 731 | Principles of Electrical and Radioactive Methods of Exploration |
| GEO 732 | Principles of Seismic Exploration |
| GEO 733 | Principles of Seismic Exploration II |
| GEO 734 | Principles of Seismic Exploration III |
| GEO 735 | Geophysical Interpretation |

PHYSICS DEPARTMENT

| | |
|---|---|
| PHY 330 | Physical Meteorology |
| PHY 430 | Dynamical Meteorology |

BATES COLLEGE OF LAW

| | |
|---|---|
| LAW 520D | Legal Control of Marine Resources |
| LAW 521F | Oil and Gas |
| LAW 521Y | International Law |
| LAW 573 | Admiralty |
| | Seminar on Pollution |

The University also offers graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

COLLEGE OF ARTS AND SCIENCES

BIOLOGY DEPARTMENT

Clark, Wallis H., Ph.D., Assistant Professor
Evans, John, Ph.D., Professor
Fotheringham, Nick, Ph.D., Assistant Professor
Lawrence, Addison L., Ph.D., Associate Professor of Biology
Mann, James E., Ph.D., Assistant Professor of Biology
Swallow, Richard L., Ph.D., Assistant Professor

GEOLOGY DEPARTMENT

Bishop, Margaret S., Ph.D., Professor of Geology
Chafetz, Henry S., Ph.D., Assistant Professor of Geology
Dobrin, Milton B., Ph.D., Professor of Geology
Lohse, E. Alan, Ph.D., Associate Professor of Geology
Maddocks, Rosalie, Ph.D., Assistant Professor of Geology
Van Siclen, DeWitt C., Ph.D., Professor of Geology

PHYSICS DEPARTMENT

Graves, Leon, S.M., Associate Professor of Physics

BATES COLLEGE OF LAW

Britton, Raymond L., LL.M., Professor of Law
Ereli, Eliezer, Ph.D., Professor of Law
Nixon, John, LL.M., Professor of Law
Newhouse, Thomas C., LL.M., Associate Professor of Law

To obtain further information, address all inquiries directly to:

Dr. Ronald F. Bunn, Dean
The Graduate School
University of Houston
Houston, Texas 77004

Dean John B. Neibel
Bates College of Law
University of Houston
Houston, Texas 77004

## HUMBOLDT STATE COLLEGE
### ARCATA, CALIFORNIA

The marine science programs at Humboldt State College offer instructional and research opportunities in marine fisheries, oceanography, and various aspects of marine biology. The proximity of the school and the Humboldt State College Marine Laboratory to all types of marine collecting sites offers the students ample field trip availability both for research and classroom work. The laboratory at Trinidad, 15 minutes from the main campus, includes a large teaching classroom and large research laboratory. A modern seawater system and various types of aquaria and trays serve the needs of the staff and students. Two vessels are used for instructional purposes. A 100-foot diesel vessel equipped for standard oceanographic and biological sampling is used for deep-sea operations, and a 40-foot diesel vessel is used for estuarine and near-shore operations. Present on-campus facilities include salt-water aquaria, a water chemistry laboratory, ichthyology laboratories, an and zoology and botany classrooms and laboratories. In addition, a newly built data processing center is now available for student use.

The College offers the following degrees through the Schools indicated:

SCHOOL OF NATURAL RESOURCES

DEPARTMENT OF OCEANOGRAPHY

1. Bachelor of Science in Oceanography.

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Math 2ABCDE, Physics 4ABCD, Geol. 1, Chem. 20ABC, Biol. 3, Zool. 1, Bot. 1, Biol. 40 or Math 25.

c. Upper division requirements: Chem 101, Chem 102, Ocn 100, Ocn 101, Ocn 102, Ocn 103, Ocn 106, Ocn 180, Ocn 190, Ocn 199.

d. Twenty-five units of approved science courses.

e. Free electives to bring total units for the B.S. degree to 192 quarter units.

SCHOOL OF SCIENCE

DEPARTMENT OF BIOLOGY

2. A.B. Degree in Biology.

a. General education: requirements as listed in the catalogue to insure breadth in the humanities, social sciences, English, and speech.

b. Lower division requirements: Biol. 3, Botany 1, Zool. 1, Chemistry 10A-10B, Physics 15A-15B.

c. Upper division requirements: Biol. 114, 119, Chem. 128, plus completion of one of the following options:

(1) Biology option: Biol. 107, Bot. 101, 110; Bot. 120 or a combination of Bot. 121 and one course from Bot. 130, 140, or 145; Zool. 101; one course from Zool. 112, 113, or 170; Zool. 114 or 160; Mathematics, 8 units beyond Math 1 and including Natural Resources 40 as an alternative.

(2) Medical Technology option: Biol. 103, 120, 124; Bot. 130; Zool. 101, 120, 121, 166, 174; Chemistry 11, 101, 102.

d. Free electives to bring total units for the A.B. degree to 186. Sixty of the total must be upper division, 36 of which must be in approved upper division science courses.

For information on Biology majors and minors for teaching, consult the College Bulletin.

3. Master of Arts in Biology.

a. Entrance Requirements:

(1) Bachelor's degree with a major in Biology, Botany, or Zoology, or related subject area approved by the Department of Biology.

(2) Overall undergraduate grade point average of 2.5 or a grade point average of 3.0 for the last 90 quarter units of credit.

b. Requirements for the degree:

(1) Completion of 45 upper division or graduate units in biology or supporting courses approved by the graduate committee, including a minimum of 18 units of graduate courses.

(2) An oral preliminary examination by the graduate committee to be taken prior to registration for the last 30 units. The purpose of this examination is to establish the candidate's deficiencies and require courses. While no one fails this examination, the candidate may be asked to repeat the exam and a poor showing may necessitate repetition of lower division and undergraduate courses without credit.

(3) Completion of a total of not less than eight or more than ten units of 290 and 299 and a thesis approved by the graduate committee.

-OR-

A special problem to be completed concurrently in enrollment of a total of four units of 290 and 299. Students electing to do a special problem rather than a thesis may not apply more than four of 125, 199, 290, or 299 toward the 45 required units.

(4) A final oral examination by the graduate committee. This will include a defense of the thesis for students electing to write a thesis.

4. A.B. Degree in Botany.

a. General education: requirements as listed by the college catalog to insure breadth in the humanities, social sciences, English and speech.

b. Lower division requirements: Biol. 3, Bot. 1, Zool. 1, Chem. 10A-10B, Physics 15A-15B, Math 15A-15B.

c. Uper division requirements: Biol. 107, 114, Zool. 101, Zool. 114 or 160, one course from Zool. 116, 135, or 165, two courses from Zool. 112, 113, or 143, Chem. 128, one Botany course (3-5 units).

d. Free electives to bring total units for the A.B. degree to 186. Sixty of the total must be upper division.

5. A.B. Degree in Zoology.

a. General education: requirements as listed by the college catalog to insure breadth in the humanities, social sciences, English and speech.

b. Lower division requirements: Biol. 3, Bot. 1, Zool. 1, Chem. 10A-10B, Physics 15A-15B, Mathematics 15A-15B.

c. Upper division requirements: Biol. 107, 114, Zool. 101, Zool. 114 or 160, one course from Zool. 116, 135, or 165, two courses from Zool. 112, 113, or 143, Chem. 128, one Botany course (3-5 units).

d. Free electives to bring total units for the degree to 186. Sixty of the total must be upper division.

The following courses are offered in conjunction with the above programs: (credits are in quarter hours)

COURSES IN OCEANOGRAPHY

UPPER DIVISION UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 100 | General Oceanography | 5 |
| 101 | Biological Oceanography | 4 |
| 102 | Physical Oceanography | 4 |
| 103 | Chemical Oceanography | 4 |
| 105 | Methods and Instruments of Oceanography | 2 |
| 106 | Geological Oceanography | 4 |
| 112 | Introduction to Marine Hydrodynamics | 3 |
| 116 | Marine Sedimentation | 5 |
| 121 | Zooplankton Ecology | 4 |
| 125 | Field Problems | 1-3 |
| 126 | Beach and Nearshore Processes | 3 |
| 131 | Marine Radioecology | 3 |
| 180 | Undergraduate Seminar | 1 |
| 181 | Seminar in Biological Oceanography | 1 |
| 182 | Seminar in Physical Oceanography | 1 |
| 183 | Seminar in Chemical Oceanography | 1 |
| 186 | Seminar in Geological Oceanography | 1 |
| 190 | Field Cruise | 3 |
| 199 | Independent Study | 1-3 |

GRADUATE COURSES

| | | |
|---|---|---|
| 211 | Dynamics of Marine Primary Profuctivity | 3 |
| 260 | Geology and Dynamics of Estuaries | 4 |
| 261 | Ecology of Estuaries | 3 |

MARINE ORIENTED COURSES IN BIOLOGY, BOTANY, AND ZOOLOGY

UPPER DIVISION UNDERGRADUATE

| | | |
|---|---|---|
| Biol 141 | Marine Biology | 4 |
| Biol 142 | Intertidal Ecology | 4 |
| Bot 141 | Phytoplankton Physiology and Ecology | 4 |

| | | |
|---|---|---|
| Bot 145 | Marine Phycology | 4 |
| Zool 112 | Invertebrate Zoology | 4 |
| Zool 113 | Invertebrate Zoology | 4 |
| Zool 143 | Comparative Physiology | 4 |

GRADUATE COURSES

| | | |
|---|---|---|
| Biol 200 | Selected Topics in Biology | 1-3 |
| Bot 200 | Selected Topics in Botany | 1-3 |
| Zool 200 | Selected Topics in Zoology | 1-4 |
| Zool 242 | Benthic Ecology | 3 |
| Zool 244 | Invertebrate Embryology | 3 |

The College also offers undergraduate and graduate programs in fisheries which are described in the Fisheries section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF OCEANOGRAPHY

Crandell, George F., Ph.D., Associate Professor of Oceanography
Gast, James A., Ph.D., Professor of Oceanography
Reinert, Richard L., B.A., Assistant Professor and Program Leader of Oceanography
Thompson, Robert W., Ph.D., Associate Professor of Oceanography

DEPARTMENT OF BIOLOGY

Allen, William, Ph.D., Associate Professor of Zoology
Brusca, Gary, Ph.D., Associate Professor of Zoology and Director of Marine Laboratory
DeMartini, John, Ph.D., Associate Professor of Zoology
Houck, Warren, Ph.D., Professor of Zoology
Rasmussen, Robert, Ph.D., Assistant Professor of Botany
Yarnall, John, Ph.D., Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

Richard L. Reinert
Program Leader, Oceanography
Humboldt State College
Arcata, California 95521

To obtain further information on Biology, write:

Gary J. Brusca
Director, Marine Laboratory
Humboldt State College
Arcata, California 95521

## INDIANA UNIVERSITY
BLOOMINGTON, INDIANA

Specialized facilities at the University include laboratory facilities in the Department of Geology for study of marine sedimentology, ecology, and geochemsitry; sampling equipment for collecting bottom sediments; gear for shallow underwater work; and laboratory facilities in the Department of Zoology for study of aquatic organisms.

No degree at Indiana University is specifically named marine science or oceanography, nor, for that matter, are other specialties in geology and zoology the basis for separately named degrees. The A.B., B.S., A.M., and Ph.D. degrees are offered in Geology, and the student can train for specialization in marine geology within both the A.M. and Ph.D. degrees. The Department of Zoology offers the A.B., B.S., A.M., and Ph.D. degrees, and the student can direct concentration toward marine zoology at the A.M. and Ph.D. levels. A.M. degree requirements: The candidate may elect to write a thesis or demonstrate reading knowledge of one foreign language, and must complete 30 semester hours of acceptable graduate credit with minimum grade average of B. Ph.D. requirements: Candidate must meet one of the following three requirements: Demonstrate proficiency in depth in one foreign language; demonstrate reading proficiency in two foreign languages; demonstrate reading proficiency in one foreign language and acquire (without credit) a specialized research skill applicable to his need. He must also complete at least 90 hours of advanced course study. There are no specific course requirements.

The following courses are offered in conjunction with the above programs:

GRADUATE COURSES

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| G 526 | Oceanography | 3 |
| G 527 | Geological Oceanography | 3 |
| G 575 | Geology of Shallow Marine Environments | 3-6 |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| Z 571 | Production Limnology | 3 |
| Z 572 | Biology of Fish Populations | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOLOGY

Dodd, J. R., Ph.D., Associate Professor
Hattin, D. E., Ph.D., Professor

DEPARTMENT OF ZOOLOGY

Frey, D. G., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Professor J. Robert Dodd
Department of Geology
Indiana University
1005 East Tenth Street
Bloomington, Indiana 47401

## THE JOHNS HOPKINS UNIVERSITY
BALTIMORE, MARYLAND

Macaulay Hall, on the Homewood Campus of the University, offers adequate office, laboratory and shop space for all branches of the oceanographic program. Other experimental facilities are available in Maryland and Latrobe Halls. The laboratories are well equipped with the general and specialized equipment required for oceanographic research. Photographic, drafting, and data reduction facilities are available to students; an extensive and active Computing Center is maintained on campus.

In addition, the resources of the Chesapeake Bay Institute, a division of the Uni-

versity engaged in oceanographic contract research, are available to students in the Department of Earth and Planetary Sciences. The C.B.I. research vessels are docked at the Institute's field laboratory at Annapolis, about an hour's drive from the campus. The 106-foot catamaran R/V RIDGELY WARFIELD is the largest of the Institute's vessels, specifically designed for research in estuarine and coastal waters. The 70-foot R/V MAURY and several smaller vessels are included in the fleet. A large barge is available for long term, on-station studies. Included in the Institute is an engineering design group for the development of new oceanographic instruments.

The Department of Earth and Planetary Sciences has an agreement with the Smithsonian Institution in Washington, D.C., which permits students to use their facilities should this be required for their research.

The Department will accept candidates for either a M.A. or Ph.D. program. Candidates for the M.A. in Oceanography must complete a prescribed program of course work in Oceanography, demonstrate a reading knowledge of French, German or Russian, complete an essay based on original work, and pass an oral examination before a committee of the Department.

Candidates for the Ph.D. will take such courses and meet such requirements as deemed necessary by their advisory committee, must satisfy the foreign language requirements of the Department, must pass a comprehensive written examination prepared by an appropriate Departmental committee and pass the oral examination administered by the Graduate Board of the University, and submit an acceptable dissertation based on original research. A year of residence at the University is required for all advanced degrees.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF EARTH AND PLANETARY SCIENCES

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 11 | Introduction to the Earth Sciences | 3 |
| 12 | Introduction to the Earth Sciences | 3 |
| 314 | Marine Geology | 5 |
| 321 | Oceanography | 3 |
| 331 | Introduction to Marine Ecology | 3 |
| 332 | Plankton Ecology | 3 |
| 396 | Mathematical Methods in Applied Sciences | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| 601 | Seminar in Oceanography | 1 |
| 602 | Seminar in Oceanography | 1 |
| 607 | Research | |
| 608 | Research | |
| 609 | Special Topics in Earth and Planetary Sciences | |
| 610 | Special Topics in Earth and Planetary Sciences | |
| 611 | Physical Oceanography | 5 |
| 612 | Physical Oceanography | 5 |
| 613 | Waves and Tides | 3 |
| 614 | Waves and Tides | 3 |
| 615 | Dynamics of Oceans and Atmosphere | 3 |
| 616 | Dynamics of Oceans and Atmosphere | 3 |
| 617 | Geophysical Fluid Mechanics | 3 |
| 618 | Geophysical Fluid Mechanics | 3 |
| 620 | Estuarine Oceanography | 3 |
| 624 | Chemistry of Sea Water | 4.5 |
| 625 | Advanced Chemical Oceanography | 4.5 |
| 631 | Biological Oceanography | 4.5 |
| 632 | Advanced Biological Oceanography | 3.5 |
| 633 | Marine Paleoecology | 2 |
| 636 | Animal-Sediment Relationships | 3 |
| 637 | Marine Benthic Ecology | 2 |
| 654 | Geochemistry | 3 |
| 659 | Turbulence | 3 |
| 660 | Turbulence | 3 |
| 670 | Marine Geology | 4.5 |
| 680 | Sedimentology | |
| 682 | Carbonate Sediments | 4.5 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF EARTH AND PLANETARY SCIENCES

Bretherton, Francis P., Ph.D., Professor of Meteorology and Oceanography
Bricker, Owen P., Ph.D., Associate Professor of Geology
Carpenter, James H., Ph.D., Associate Professor of Oceanography
Eugster, Hans P., D.Sc., Professor of Geology
Hardie, Lawrence A., Ph.D., Associate Professor of Geology
Logan, Brian, Ph.D., Visiting Professor of Geology
Long, Robert R., Ph.D., Professor of Fluid Mechanics
Marcus, Allan, Ph.D., Associate Professor of Statistics and Earth and Planetary Sciences
Montgomery, Raymond B., Sc.D., Professor of Oceanography
Pettijohn, Francis J., Ph.D., Professor of Geology
Phillips, Owen M., Ph.D., Chairman and Professor of Geophysics
Pritchard, Donald W., Ph.D., Professor of Oceanography
Stanley, Steven M., Ph.D., Assistant Professor of Paleobiology
Taylor, W. Rowland, Ph,D., Associate Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dr. Owen Phillips, Chairman
Department of Earth and Planetary Sciences
The Johns Hopkins University
Charles and 34th Streets
Baltimore, Maryland 21218

## LAMAR STATE COLLEGE OF TECHNOLOGY
BEAUMONT, TEXAS

The laboratory facilities are distributed among two science and three engineering buildings, all of which are of recent construction or renovation. In 1969 the campus data processing center moved into new quarters equipped with a Control Data 3300 computer system. The college library has acquired 450 titles to support this program. In 1970 the City of Port Arthur donated to the college property fronting on Sabine Lake (estuary) to be used as a shore base for field operations. Until laboratory facilities are constructed

there, field instruction will be conducted from the large boat. Assigned to the program are a 64-foot patrol boat and a 16-foot outboard boat. A 36-foot catamaran for shallow water work is under construction, and should be in service by 1971-72.

The B.S. in Oceanographic Technology is offered as an interdisciplinary program by the departments of Biology, Geology, Civil Engineering, and Electrical Engineering. In addition to meeting the college's general education requirements for the bachelors degree, the student must show competence in field and shipboard operations, the use of sampling and electronic data gathering equipment and techniques, and the processing of oceanographic data. He must demonstrate basic theoretical knowledge in the several scientific and engineering disciplines which constitute oceanography. Each student must earn 12 semester hours of Biology, 8 semester hours of Chemistry, 19 hours of Geology, Meteorology, and Oceanography, 8 semester hours of Physics, 12 semester hours of Mathematics, and 16 semester hours of Engineering and Computer Science.

UNDERGRADUATE COURSES

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 445 | Marine Biology | 4 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 337 | Meteorology | 3 |
| 344 | General Oceanography | 4 |
| 419 | Seminar | 1 |
| 423 | Shipboard Operations | 2 |
| 433 | Geophysics | 3 |
| 421 | Physical Oceanography | 2 |

ENGINEERING CORE PROGRAM

| | | |
|---|---|---|
| 121 | Engineering Graphics | 2 |
| 122 | Introduction to Digital Computers | 2 |
| 212 | Production and Fabrication Processes | 1 |
| 233 | Electric Circuits and Fields | 3 |
| 421 | Data Processing | 2 |

DEPARTMENT OF CIVIL ENGINEERING

| | | |
|---|---|---|
| 331 | Environmental Science | 3 |

DEPARTMENT OF ELECTRICAL ENGINEERING

| | | |
|---|---|---|
| 438 | Instrumentation | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Robertson, Phillip B., Ph.D., Assistant Professor, Marine Biology

DEPARTMENT OF GEOLOGY

Lins, T. Wesley, Ph.D., Assistant Professor, Oceanography
Pampe, William R., Ph.D., Associate Professor, Meteorology
Roberts, William P., M.S., Assistant Professor, Sedimentation

DEPARTMENT OF CIVIL ENGINEERING

Delflache, Andre P., Sc.D., Professor, Soils Mechanics

DEPARTMENT OF ELECTRICAL ENGINEERING

Cherry, Lloyd B., M.A., Professor and Dean of Engineering, Circuits and Fields
Crum, Floyd M., M.S., Professor, Oceanographic Instrumentation

To obtain further information, address all inquiries directly to:

H.E. Eveland, Head
Department of Geology
Box 10031, LT Station
Beaumont, Texas 77705

## LEHIGH UNIVERSITY
### BETHLEHEM, PENNSYLVANIA

The University offers marine science and ocean engineering courses on its main campus at Bethlehem, Pennsylvania. The Center for Marine and Environmental Studies (CMES) was established in 1962 as a faculty and graduate student research organization to encourage interdisciplinary research in marine science, ocean engineering and environmental studies. CMES is interdepartmental, and provides opportunities for staff and students from the fields of biology, biochemistry, chemistry, geological sciences and physics, and chemical, civil and mechanical engineering to carry out research on problems of common interest in the marine environment.

CMES is organized in four laboratories. The Marine Biology Laboratory is equipped for studies in marine ecology, with several temperature-controlled artificial saltwater aquaria. The Marine Biochemistry Laboratory is equipped for microbiological and biochemical research, particularly on proteolytic enzymes of marine bacteria. The Marine Geotechnical Laboratory, a well-equipped facility for geotechnical ocean engineering research, contains specialized apparatus for measuring significant engineering and mass physical and chemical properties of bottom sediments in the laboratory and at sea. The Institute of Pathobiology was established in 1970 and is being equipped to study abnormal and diseased conditions of marine invertebrates, fish and plants.

Additional facilities available on campus include: the sedimentation and geochemistry laboratories in geology; the Hydraulics Division of Fritz Laboratory with a variety of flumes, wave tanks, and sedimentation tanks and tables; the University Computing Center and CDC-6400 computer; and many major items of equipment shared with other departments, such as an ARL electron microprobe.

Work at sea is done through cooperation with other institutions. During 1970, faculty and students obtained ship time on vessels operated by Texas A&M University, Duke University, the Coast Guard, the Atlantic Oceanographic Laboratories of ESSA in Miami, and Lockheed Oceanographic Laboratory. Research was also performed at the Sandy Hook Laboratory of the U.S. Bureau of Fish and Wildlife, and the Bermuda Biological Station.

Under a three year Sea Grant Coherent Area Research Program, Lehigh is developing and using in-situ soil mechanics probes from submersibles, in cooperation with Lockheed

Ocean Laboratory and using the submersible DEEP QUEST.

The M.S. and Ph.D. degrees are awarded in biology, chemistry, chemical engineering, civil engineering, geology, mechanical engineering, and physics. Graduate options or minors in Marine Science and Ocean Engineering are available.

The Center for Marine and Environmental Studies is not an academic department and does not itself offer degrees. Rather than establish new departments, Lehigh is developing mechanisms for interdepartmental graduate programs which can be arranged on an individual basis with special committees of faculty.

Master of Science. All candidates must satisfactorily complete at least two full semesters of advanced work. The minimum program for the master's degree must include:

a. Not less than 30 semester hours of graduate work.
b. Not less than 18 hours of "400" level course work.
c. Not less than 18 hours in the major field.
d. Not less than 15 hours of "400" courses in the major field.

The proposed program of courses must obtain the approval of the chairman of the student's major department or the chairman of the interdepartmental program. Approval of the program by the Graduate Committee signifies that the student has formally been admitted to candiacy for the degree. In order to qualify for the master's degree, candidates will be required (a) to submit a thesis or a report based on a research course of at least three credit hours, and/or (b) to pass a comprehensive examination given by the major department. If required, the thesis shall not count for more than six semester hours.

The master's degree is not granted unless the candidate has earned the grades "A" or "B" in at least eighteen hours of the work of his program. No course in which the grade earned is less than "C" is credited toward the degree. When all requirements have been met, the candidate is recommended by the faculty to the trustees for the master's degree appropriate to the work pursued.

Doctor of Philosophy. The degree of Doctor of Philosophy is conferred on candidates who have demonstrated general proficiency and high attainment in a special field of knowledge and capacity to carry on independent investigation in that field as evidenced by the presentation of an acceptable dissertation embodying the results of original research.

A candidate ordinarily is expected to devote three or more academic years to graduate study. Graduate work done in residence at other institutions may be accepted in partial fulfillment of the time requirements. A candidate for the degree must complete at least one full academic year or resident graduate study at Lehigh University.

Preparation for the degree is based on the study of a major subject to which one or two minors may be added. The program of work, to be formulated by the candidate, his special committee, and the chairman of his major department, should be planned to lead to a general mastery of the major field and to a significant grasp of any minor that may be added.

Foreign language requirements are the option of the candidate's major department or interdepartmental program committee, and are not a University requirement for the degree.

The general examinations for the doctorate are designed to test both the student's capacity and his proficiency in his field of study and may be both oral and written.

The candidate is required to present a dissertation prepared under the general direction of a professor at Lehigh University. The disseration shall treat a topic related to the candidate's major subject, embody the results of original research, give evidence of high scholarship, and constitute a contribution to knowledge. An oral examination on the dissertation is required.

The following courses are offered in conjunction with the above programs:

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

| | | |
|---|---|---|
| Geo 363 | Introduction to Oceanography | 3 |
| CE 328 | Channel and Oceanographical Hydraulics | 3 |
| CE 332 | Ocean Engineering | 3 |
| CE 333 | Ocean Engineering Field Investigations | 1-3 |
| ME 350 | Fluid Mechanics of the Ocean and Atmosphere | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| Bio 417 | Marine Ecology | 3 |
| Bio 418 | Biological Oceanography | 3 |
| Bio 480 | Marine Science Seminar | 1 |
| Ce 431 | Geotechnical Ocean Engineering | 3 |
| CE 439 | Ocean Engineering Research | 1-6 |
| Geo 461 | Marine Geology | 3 |

A wide variety of other courses, both undergraduate and graduate, are offered by various departments to provide the basic skills required for research in the marine sciences and ocean engineering.

The instructional staff for the courses listed above consists of the following:

BIOLOGY DEPARTMENT

Barber, Saul B., Ph.D., Professor of Biology
Cheng, Thomas C., Ph.D., Professor of Biology
Herman, Sidney S., Ph.D., Associate Professor of Biology
Malsberger, Richard W., Ph.D., Professor of Biology

CHEMICAL ENGINEERING DEPARTMENT

Kleinberg, Sidney, Ph.D., Assistant Professor of Chemical Engineering

CHEMISTRY DEPARTMENT

Diefenderfer, A. James, Ph.D., Associate Professor of Chemistry
Merkel, Joseph R., Ph.D., Professor of Biochemistry

CIVIL ENGINEERING DEPARTMENT

Graf, Walter, Ph.D., Associate Professor of Civil Engineering
Richards, Adrian F., Ph.D., Professor of Oceanography and Ocean Engineering

GEOLOGICAL SCIENCES DEPARTMENT

Carson, Bobb, Ph.D., Assistant Professor of Geology
Parks, James M., Ph.D., Professor of Geology
Richards, Adrian F., Ph.D., Professor of Oceanography and Ocean Engineering
Ryan, J. Donald, Ph.D., Professor of Geology

MECHANICAL ENGINEERING AND MECHANICS DEPARTMENT

Terry, Theodore A., Ph.D., Associate Professor of Mechanical Engineering
Stenning, Alan H., Sc.D., Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Dr. James M. Parks, Director
Center for Marine and Environmental Studies
Lehigh University
Bethlehem, Pennsylvania 18015

## LONG ISLAND UNIVERSITY
## C.W. POST CENTER
### GREENVALE, NEW YORK

The Graduate Department of Marine Science comprises three groups: (1) Marine biology, with concentration in marine protistology, environmental chemistry and fish sciences; (2) Geophysical sciences, with concentration in physical oceanology, marine geology and atmospheric science; and (3) Technology, with concentration in ocean engineering, instrumentation, and environmental pollution science. The Department was organized in 1965, and in 1967 moved to its present location at the Mitchel Campus (a branch of the C.W. Post Center) with 26,000 square feet of teaching and research space. The Department operates a 56-foot ocean going motor sailer, the R/V LUCAYO, a 28-foot inshore boat, the R/V ELDON, and several small craft and aircraft. In addition, there is a mobile field laboratory for coastal ecological work. Laboratory facilities include numerous fish holding tanks, pilot plant aquaculture tanks, high pressure test equipment, wave simulators, and radioisotope equipment. Facilities at the University's Southampton campus and the New York Ocean Science Laboratory are also utilized. The Department also operates an extension at the Marine Science Training Center, U.S. Coast Guard, Governor's Island, New York.

The M.S. in Marine Science is offered by the University. A student accepted into the Department of Marine Science should meet with the Department Chairman for assignment of an advisor who will assist in planning a degree program in one of the three areas of concentration. No student will be accepted for matriculation until he has drawn up a program of study approved by the Department Chairman and the Dean. Candidates for the degree of Master of Science with a concentration in Marine Science must:

1. Complete satisfactorily a minimum of 36 semester hours of credit in a program approved by a major advisor. Up to 12 semester hours of credit may be taken in other departments or other universities, when approved by an advisor.

2. Complete one year of Marine Biology (501. 502), Physical Oceanography (651, 652), and Seminar (701, 702).

3. Present a thesis (in Marine Science 707, 708) which satisfactorily demonstrates competence in research, and take an oral examination on the thesis. A student concentrating in Ocean Engineering may, however, take Marine Science 709 instead of Marine Science 707, 708 if he has obtained the approval of his advisor.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| M.S. 501 | Marine Biology | 3 |
| M.S. 502 | Marine Biology | 3 |
| M.S. 503 | Survey of Oceanography | 3 |
| M.S. 504 | Survey of Oceanography | 3 |
| M.S. 608 | Marine Ecology | 3 |
| M.S. 609 | Marine Ecology | 3 |
| M.S. 610 | Marine Microbiology | 4 |
| M.S. 611 | Marine Microbiology | 4 |
| M.S. 615 | Behavior of Marine Organisms | 3 |
| M.S. 616 | Behavior of Marine Organisms | 3 |
| M.S. 621 | Marine Botany | 3 |
| M.S. 622 | Marine Botany | 3 |
| M.S. 631 | Ichthyology | 4 |
| M.S. 632 | Ichthyology | 4 |
| M.S. 634 | Marine Invertebrate Zoology | 3 |
| M.S. 636 | Fisheries Biology | 3 |
| M.S. 637 | Fisheries Biology | 3 |
| M.S. 641 | Biochemistry of Marine Organisms | 4 |
| M.S. 642 | Biochemistry of Marine Organisms | 4 |
| M.S. 643 | Environmental Pollution | 3 |
| M.S. 644 | Environmental Pollution | 3 |
| M.S. 651 | Physical Oceanography | 3 |
| M.S. 652 | Physical Oceanography | 3 |
| M.S. 653 | Field Work in Oceanography | 3 |
| M.S. 654 | Field Work in Oceanography | 3 |
| M.S. 655 | Advanced Physical Oceanography | 3 |
| M.S. 656 | Advanced Physical Oceanography | 3 |
| M.S. 657 | Marine Acoustics | 3 |
| M.S. 658 | Marine Acoustics | 3 |
| M.S. 659 | Meteorology | 3 |
| M.S. 660 | Meteorology | 3 |
| M.S. 661 | Marine Geochemistry | 3 |
| M.S. 662 | Marine Sedimentation | 3 |
| M.S. 663 | Marine Sedimentation | 3 |
| M.S. 664 | Marine Geology | 3 |
| M.S. 665 | Marine Geology | 3 |
| M.S. 668 | Methods of Geophysical Fluid Dynamics | 3 |
| M.S. 669 | Methods of Geophysical Fluid Dynamics | 3 |
| M.S. 667 | The Coastal Environment | 3 |
| M.S. 674 | Environmental Microbiology and Chemistry | 4 |
| M.S. 675 | Environmental Microbiology and Chemistry | 4 |
| M.S. 681 | Marine Instrumentation | 3 |
| M.S. 682 | Marine Instrumentation | 3 |
| M.S. 691 | Marine Operations | 3 |
| M.S. 693 | Ocean Engineering | 3 |
| M.S. 694 | Ocean Engineering | 3 |
| M.S. 695 | Advanced Ocean Engineering | 3 |
| M.S. 696 | Advanced Ocean Engineering | 3 |
| M.S. 701 | Marine Science Seminar | 1 |
| M.S. 702 | Marine Science Seminar | 2 |
| M.S. 707 | Research and Thesis | 3 |
| M.S. 708 | Research and Thesis | 3 |
| M.S. 709 | Ocean Engineering Research | 3 |

The instructional staff for the courses listed above consists of the following:

Bane, Gilbert, Ph.D., Adj. Assoc. Professor, Fisheries Biology
Cahn, Phyllis H., Ph.D., Professor, Fish

Behavior
Devine, Michael, Ph.D., Asst. Professor, Oceanography
Freudenthal, Hugo D., Ph.D., Department Chairman
Freudenthal, Peter, Ph.D., Adj. Asst. Professor, Meteorology
Hamlin, Norman, M.S., Adj. Professor, Ocean Engineering
Hope, Richard, B.L., Adj. Assoc. Professor, Marine Operations
Levenstein, Harold, M.S., Adj. Asst. Professor, Experimental Design
McIlroy, William, Ph.D., Adj. Assoc. Professor, Acoustics
Newman, Bernard, Ph.D., Professor, Sanitary Microbiology
Penn, Sheldon, M.S., Adj. Asst. Professor, Sedimentation
Price, David, M.S., Adj. Asst. Professor, Ocean Engineering
Romer, Harold, M.S., Adj. Professor, Environmental Engineering
Seabrooke, James, Adj. Asst. Professor, Oceanography
Uzzo, Anthony, Ph.D., Adj. Assoc. Professor, Instrumentation
Siler, William, Research Associate
Valenti, Robert, Research Associate
Schulein, Walter, Manager of Operations

To obtain further information, address all inquiries directly to:

Dr. Hugo D. Freudenthal
Graduate Department of Marine Science
Long Island University, Mitchel Campus
40 Merrick Avenue
East Meadow, New York 11554

## LONG ISLAND UNIVERSITY
## SOUTHAMPTON COLLEGE
### SOUTHAMPTON, NEW YORK

The Division of Natural Sciences Instructional, laboratory and research space approximates 21,500 square feet which includes a one acre campus Marine Station of 4,500 square feet with dock side facilities. Vessels owned and operated by the Division include the SHAWNA IV, a 38-foot twin diesel research vessel which is equipped with radar, loran, recording fathometer, s/s and CB radio, electrically driven one ton capacity hydrographic winch with 1000 feet of wire, and a small wet laboratory. Additional research vessels include two 24-foot pontoon platform outboard powered vessels; one 20-foot sea skiff; one 19-foot and one 17-foot fiberglass utility boat. These five vessels are equipped with winch, davit or A-frame and metering wheel, fathometers, and specialized sampling and collecting equipment as required for shallow water and estuarine work.

The B.A. in Marine Science is offered with concentration in biological, chemical or geological areas of study. All marine science majors must take the following courses as prerequisites: Math 105, 106, 201, 202 (College Math through Calculus); Physics 201-202 Introductory Calculus Physics; Biology 101-106 or Introductory Geology: and Chemistry 101-102 (General), 201 (Quantitative Analysis).

All marine sciences majors must take the marine science sequence M.S. 309, M.S. 310, M.S. 390, M.S. 397-398.

All majors must select one area of concentration from:

a) Biological: Bio. 201, 203, 210 or 211, 221, 321, M.S. 222, M.S. 341, M.S. 311, Chem. 203, 204 (Organic) or 301 (Phys. Chem).
b) Chemical: Chem. 202, 203-204, 301-302, 304 plus Electives, e.g., Geol. 302-Geochemistry.
c) Geological: Geol. 113, 114, 115, 116, 119, 205, 207, and 338.

In addition, all majors select three or four elective courses plus six to eight courses in Humanities, Social Sciences and Language.

The following courses are offered in conjunction with the above program:

MARINE SCIENCE DEPARTMENT

| | | |
|---|---|---|
| MS 11 | Introductory Oceanography | 4 |
| MS 107 | Meteorology | 3 |
| MS 222 | Fisheries Biology | 3 |
| MS 309 | Physical Oceanography | 4 |
| MS 310 | General Oceanography | 4 |
| MS 311 | Plankton and Primary Productivity | 4 |
| MS 338 | Marine Geology | 3 |
| MS 341 | Marine Ecology | 3 |
| MS 390 | Marine Operations and Research | 8 |
| MS 393 | Independent Study | 1-3 |

BIOLOGY DEPARTMENT

| | | |
|---|---|---|
| Bio 201 | Marine Phycology | 3 |
| Bio 203 | Invertebrate Zoology | 3 |
| Bio 210 | Microbiology | 3 |
| Bio 211 | Genetics | 4 |
| Bio 221 | Ichthyology | 3 |
| Bio 242 | Conservation of Natural Resources | 3 |
| Bio 321 | Physiology | 3 |

CHEMISTRY DEPARTMENT

| | | |
|---|---|---|
| Chem 201 | Quantitative Analysis | 4 |
| Chem 202 | Theory of Instrumental Analysis | 3 |
| Chem 203 | Organic Chemistry | 4 |
| Chem 204 | Organic Chemistry | 4 |
| Chem 301 | Physical Chemistry for Life Sciences | 4 |
| Chem 302 | Physical Chemistry | 3 |
| Chem 304 | Advanced Inorganic Chemistry | 3 |

GEOLOGY DEPARTMENT

| | | |
|---|---|---|
| Geo 113 | Mineralogy | 3 |
| Geo 114 | Mineralogy | 3 |
| Geo 115 | Sedimentology | 3 |
| Geo 116 | Stratigraphy | 3 |
| Geo 119 | Paleontology | 3 |
| Geo 205 | Structural Geology | 3 |
| Geo 207 | Coastal Processes | 3 |

The instructional staff for the courses listed above consists of the following:

DIVISION OF NATURAL SCIENCES

Achuthan, Radh, M.S., Assistant Professor of Physics
Andrews, John W., Ph.D., Assistant Professor of Physics
Badzinski, Stanley R., B.S., Instructor of Biology
Barnes, Steven S., Ph.D., Assistant Professor of Chemistry

Bane, Gilbert W., Ph.D., Associate Professor of Biology
Berkebile, C. Alan, Ph.D., Associate Professor of Geology
Briles, George, Ph.D., Associate Professor of Chemistry
Burke, William T., Ph.D., Professor of Biology and Director of Division
Catanzaro, Edward J., Ph.D., Assistant Professor of Geology
Coher, Edward I., Ph.D., Associate Professor of Biology
Collins, John, Marine Operations
Curtis, John E., M.S.E., Assistant Professor of Mathematics
Danziger, Robert, Ph.D., Assistant Professor of Chemistry
Duberman, Daniel, D.V.M., Assistant Professor of Biology
Getz, Donald, B.A., Assistant Marine Station Manager
Greiner, Gary O. G., Ph.D., Assistant Professor of Geology
Haresign, Thomas, Ph.D., Associate Professor of Biology
Hehre, Edward, Ph.D., Assistant Professor of Biology
McCormick, C. L., Ph.D., Assistant Professor of Geology
Reisman, Howard M., Ph.D., Assistant Professor of Biology
Sevian, Walter A., Ph.D., Assistant Professor of Mathematics
Siegel, Alvin, Ph.D., Professor of Chemistry
Smith, Arthur E., M.Ed., Assistant Professor of Mathematics
Stevens, Nathaniel H., M.S., Associate Professor of Mathematics
Welker, J. R., M.S., Assistant Professor of Marine Sciences

ADJUNCT FACULTY

Delihas, Nicholas, Ph.D., Professor of Biology
Hahn, Steven, B.S., Associate Professor of Marine Electronics and Instrumentation
Hitchcock, Anthony, M.S., Assistant Professor of Biology
Price, Jessie, Ph.D., Associate Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. William T. Burke
Director, Division of Natural Sciences
Southampton College
Southampton, New York 11968

## LOUISIANA STATE UNIVERSITY
### BATON ROUGE, LOUISIANA

Marine Sciences education at L.S.U. is focused on the study, management and development of marshlands, estuaries, shallow-water environments and related resources typical of the coastal zone. The department and cooperating University organizations provide extensive aerial photograph and map collections, nuclear and computer science facilities, chemical analysis capabilities, biological and sedimentological laboratories and sampling equipment, boats and skiffs for nearshore operations, machine shops, photographic laboratories and library facilities. Field operations in Louisiana are conducted from University-leased facilities on Grand Isle or from those provided through cooperation with the extensive marshland refuge system operated by the Louisiana Wild Life and Fisheries Commission. The operations base at Grand Isle includes living space for eight to ten people and a portable laboratory building. A smaller, float mounted, laboratory is available for on-site work in the marsh or estuaries. Although larger boats can be berthed at nearby marinas, most field work is conducted with boats in the 16 to 24-foot class and small skiffs. The Department of Marine Sciences is affiliated with LSU's Coastal Studies Institute (CSI) and Office of Sea Grant Development (OSGD), and facilities of these organizations play an important role in departmental research and instructional programs. CSI research programs, conducted primarily under the auspices of the Geography Programs, Office of Naval Research, are international in scope. With the exception of Antarctica, coastal and deltaic areas of all continents have been studied by Institute personnel. LSU Sea Grant activities concentrate on the multiple and optimum utilization of Louisiana's marshlands and estuaries. The more than 4,700 square miles of fresh- to brackish-water marsh found in Louisiana represent a vast natural scientific laboratory and an important nursery ground for shrimp, oysters, crabs, and commercial fish species. CSI and OSGD personnel form the core faculty of the Department of Marine Sciences.

The Department of Marine Sciences was created in 1968 to develop graduate level courses and degree programs in the subject field and to encourage expansion of marine-related research and instruction in regular academic departments. Implicit in its creation was the concept that, although the department should serve as a focus for marine activities, development of courses and programs would be highly dependent upon existing discipline-based competence in established University departments, schools, and institutes.

In view of the interdisciplinary nature of marine sciences and the variety of student specialization fields (e.g., physical oceanography, marine biology, fisheries, etc.), each curriculum for an M.S. or Ph.D. program must be specifically developed for the individual student. Certain core courses (M.S. 126, M.S. 170, M.S. 171, M.S. 172) or equivalents will be required to provide a broad coverage of marine science disciplines, but considerable flexibility is exercised to permit development of curricula tailored to individual student needs.

1. M.S. in Marine Sciences. In conjunction with requirements and scheduling specified in the current issue of the Bulletin of the Louisiana State University Graduate School the Master of Science degree in Marine Sciences requires:

a. A program of study approved by the Department Chairman and the student's major professor. The program will normally consist of a minimum of 24 hours of graduate-level courses and six hours of thesis research. Courses will usually include two core courses or equivalents and at least two 200-level courses. In addition, at the request of the major professor, a proficiency in Mathematics 57 may be required of students in certain programs. The remaining electives may be chosen with the consent of the student's major professor from other appro-

priate courses in the Department of Marine Sciences or other departments.

Research culminating in the preparation of an acceptable Master's thesis should demonstrate the capacity for originality of thought, research, and facility in organizing material.

b. An average grade not lower than B and no grade lower than C in the courses offered for the degree.

c. Passing a final oral examination based largely on the student's area of specialization, aspects of his research problem and past course work.

d. Although a reading knowledge of a foreign language is not required of a candidate for the Master's degree, the major professor may recommend some exposure to a particular language if a large body of foreign-language literature exists in the candidate's specialty field. In some specialty fields recommendations may be made to develop the student's proficiency in statistics, computer sciences, etc., rather than in a foreign language.

2. Ph.D. in Marine Sciences. In conjunction with requirements and scheduling specified in the current issue of the Bulletin of the Louisiana State University Graduate School the Doctor of Philosophy degree in Marine Sciences requires:

a. A program of study approved by the student's major professor and advisory committee consisting of (a) at least 48 hours of course work beyond the baccalaureate. (Course work will normally include several core courses or their equivalents plus a minimum of 12 hours of appropriate 200 level courses in the department. In addition, the student must select a minor in another department--or an internal minor approved by the Graduate Council. The remaining electives may be selected from other courses designed to complete the student's program of study.) (b) A maximum of 12 hours of research leading to a dissertation in some area of marine science.

b. An average grade not lower than B and no grade lower than C in the courses offered for the degree.

c. A reading knowledge of at least one language other than his native language. The language is to be selected from the following: (1) German, (2) Russian, (3) French, (4) Spanish, (5) English. The candidate's selection should be based upon the abundance of foreign-language scientific literature in his field of specialization. The language requirement must be met prior to scheduling the general examination.

d. Passing a comprehensive written and oral qualifying examination covering the student's scientific background and training, course work, and general capabilities in the scientific field. This examination should be taken during the first semester after the Master's degree is awarded or after one year of graduate study for students not taking the Master's degree.

e. Passing a comprehensive general examination consisting of written and oral portions in a manner that conclusively demonstrates the student's competence over broad segments of marine sciences and a high degree of familiarity with current progress in one or more minor fields.

f. Passing an oral final examination based on the dissertation research.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF MARINE SCIENCES

| | | |
|---|---|---|
| 126 | Chemical Oceanography | 3 |
| 164 | Marine Resources Law | 3 |
| 170 | Physical Oceanography | 3 |
| 171 | Coastal and Marine Meteorology | 3 |
| 172 | Estuarine Ecology | 3 |
| 209 | Coastal Swamps and Marshes | 3 |
| 210 | Form-Process Relationships in Coastal Environments | 3 |
| 216 | Coastal and Shallow-Water Literature | 3 |
| 222 | Gravity Waves in Shallow Water | 3 |
| 223 | Shore Dynamics | 3 |
| 225 | Estuarine and Shallow-Water Oceanography | 3 |
| 231 | Geochemistry of Coastal Water, Soils, and Sediments | 3 |
| 232 | Coastal Physical/Chemical Systems: Analytical Methods | 3 |
| 241 | Coastal Ecology | 3 |
| 242 | Coastal Climatology | 3 |
| 246 | Coastal and Estuarine Resources | 3 |
| 298 | Advanced Reading and Literature Research | 3-6 |
| 299 | Advanced Field Research | 3-6 |
| 300 | Thesis Research | 1-6 |
| 400 | Dissertation Research | 1-9 |

DEPARTMENT OF BIOCHEMISTRY

| | |
|---|---|
| 187 | Basic Biochemistry |

DEPARTMENT OF BOTANY

| | |
|---|---|
| 138 | Plant Ecology |
| 203 | Mineral Nutrition of Plants |
| 205 | Mineral Nutrition of Plants Laboratory |

DEPARTMENT OF CHEMICAL ENGINEERING

| | |
|---|---|
| 101 | Transport Science: Momentum Transfer |
| 102 | Transport Science: Heat and Mass Transfer |

DEPARTMENT OF CIVIL ENGINEERING

HYDRAULIC ENGINEERING

| | |
|---|---|
| 162 | Fluid Mechanics |
| 163 | Hydraulics |
| 165 | Hydrology |
| 203 | Free Surface Flow |
| 206 | Advanced Hydraulics |
| 280 | Advanced Hydrology |
| 290 | Optimization Techniques in the Planning, Design and Operation of Water Resources Systems |

ENGINEERING

| | |
|---|---|
| 111 | Environmental Engineering |

DEPARTMENT OF EXPERIMENTAL STATISTICS

| | |
|---|---|
| 201 | Basic Statistical Methods |
| 202 | Advanced Statistical Methods |
| 206 | Principles of Experimental Design |

DEPARTMENT OF FOOD SCIENCE

| | |
|---|---|
| 101 | Food Process Engineering |
| 143 | Food Technology I |
| 144 | Food Technology II |
| 170 | Food and Drug Laws, Standards, and Regulations |

| | |
|---|---|
| 175 | Food Preservation |
| 182 | Plant Metabolism |
| 186 | Marine Food Resources and Technology |
| 230 | Advanced Food Research - Marine Food Products |
| 271 | Seminar in Food Science |
| 272 | Seminar in Food Technology |

SCHOOL OF FORESTRY AND WILDLIFE MANAGEMENT

WILDLIFE AND FISHERIES

| | |
|---|---|
| 121 | Ichthyology |
| 124 | Fur Animal Management |
| 125 | Limnology |
| 126 | Fundamentals of Fish Culture |
| 157 | Special Problems |
| 225 | Advanced Game Management - Waterfowl |
| 230 | Fish Parasites and Diseases |
| 232 | Fishery Research Techniques |
| 236 | Water Pollution Biology |
| 238 | Fisheries Hydrography |
| 239 | Shellfisheries Biology |
| 240 | Mariculture |

SCHOOL OF GEOSICENCES

GEOGRAPHY AND ANTHROPOLOGY

| | |
|---|---|
| 101 | Geography of Louisiana |
| 113 | Meteorology |
| 114 | Climatology |
| 115 | Microclimatology |
| 119 | Aerial Photo Interpretation I |
| 120 | Aerial Photo Interpretation II |
| 121 | Alluvial Geomorphology |
| 123 | Coastal Morphology |
| 128 | Marine and Coastal Environments: Natural |
| 129 | Marine and Coastal Environments: Cultural |
| 260 | Hydroclimatology |

GEOLOGY

| | |
|---|---|
| 124 | Deltaic Geology |
| 131 | Introductory Sedimentology and Stratigraphy |
| 142 | Introductory Geophysics |
| 159 | Introductory Geochemistry |
| 232 | Dynamics of Sedimentation |
| 233 | Sedimentary Petrology of Carbonates |
| 234 | Clay Mineralogy |
| 251 | Paleoecology |
| 256 | Oceanographic Geochemistry |
| 259 | Low-Temperature Physical Geochemistry |
| 260 | Advanced Topics in Geochemistry |

DEPARTMENT OF HOME ECONOMICS

| | |
|---|---|
| 123 | Human Nutrition |

DEPARTMENT OF MICROBIOLOGY

| | |
|---|---|
| 161 | Microbiology of Water, Sewage and Industrial Wastes |
| 200 | Electron Microscopy of Biological Materials |
| 221 | Virology |

NUCLEAR SCIENCE CENTER

| | |
|---|---|
| 101 | Radioisotope Techniques |
| 201 | Advanced Tracer Methodology for Biological Sciences |

DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY

| | |
|---|---|
| 147 | Marine Vertebrate Zoology |
| 151 | Marine Invertebrate Zoology |
| 153 | Animal Ecology |
| 236 | Seminar in Ecology |
| 237 | Seminar in Ecology |
| 238 | Seminar in Systematics, Evolution and Zoogeography |
| 239 | Seminar in Systematics Evolution and Zoogeography |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF MARINE SCIENCES

Coleman, James M., Ph.D., Associate Professor of Marine Sciences
Ford, Ted B., Ph.D., Professor of Marine Sciences
Gagliano, S. M., Ph.D., Associate Professor of Marine Sciences
Ho, Clara L., Ph.D., Associate Professor of Marine Sciences
Hsu, Shih-Ang, Ph.D., Assistant Professor of Marine Sciences
Loesch, Harold C., Ph.D., Professor of Marine Sciences
Murray, Stephen P., Ph.D., Assistant Professor of Marine Sciences
Smith, W. G., Ph.D., Assistant Professor of Marine Sciences
Sonu, Choule J., Ph.D., Associate Professor of Marine Sciences
Van Lopik, Jack R., Ph.D., Chairman and Professor of Marine Sciences

DEPARTMENT OF BIOCHEMISTRY

Allen, R. Scott, Ph.D., Head and Professor of Biochemistry

DEPARTMENT OF BOTANY

Gosselink, James G., Ph.D., Associate Professor of Botany

DEPARTMENT OF CHEMICAL ENGINEERING

Pike, Ralph W., Ph.D., Associate Professor of Chemical Engineering
Wilkins, Bert, Ph.D., Assistant Professor of Chemical Engineering

DEPARTMENT OF CIVIL ENGINEERING

Kamel, Adel M., Ph.D., Associate Professor of Civil Engineering

DEPARTMENT OF FOOD SCIENCE

Grodner, Robert M., Ph.D., Professor of Food Science
Liuzzo, Joseph A., Ph.D., Professor of Food Science
Meyers, Samuel P., Ph.D., Professor of Food Science
Novak, Arthur F., Ph.D., Head and Professor of Food Science
Rao, Ramachandra M. R., Ph.D., Assistant Professor of Food Science

SCHOOL OF FORESTRY AND WILDLIFE MANAGEMENT

Avault, James W., Ph.D., Associate Professor of Fisheries
Culley, Dudley D., Ph.D., Assistant Professor of Fisheries
Truesdale, Frank M., Ph.D., Assistant

Professor of Fisheries

DEPARTMENT OF GEOGRAPHY AND ANTHROPOLOGY

McIntire, William G., Ph.D., Professor of Geography and Marine Sciences
Muller, Robert A., Ph.D., Associate Professor of Geography
Walker, H. J., Ph.D., Chairman and Professor of Geography and Anthropology
West, Robert, Ph.D., Boyd Professor of Geography and Anthropology

DEPARTMENT OF GEOLOGY

Ferrell, Ray E., Ph.D., Assistant Professor of Geology
Hanor, Jeffrey S., Ph.D., Assistant Professor of Geology
Moore, Clyde H., Ph.D., Associate Professor of Geology
Morgan, James P., Ph.D., Chairman and Professor of Geology
Perkins, Robert F., Ph.D., Professor of Geology

SCHOOL OF LAW

Hardy, George W., J.D., Professor of Law
Knight, H. Gary, J.D., Assistant of Law and Marine Sciences

DEPARTMENT OF MICROBIOLOGY

Colmer, Arthur R., Ph.D., Alumni Professor of Microbiology
Socolofsky, M. D., Ph.D., Chairman and Professor of Microbiology

DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY

Bennett, Harry J., Ph.D., Professor of Zoology
Harman, Walter J., Ph.D., Chairman and Professor of Zoology and Physiology

To obtain further information, address all inquiries directly to:

Dr. Jack R. Van Lopik, Chairman
Department of Marine Sciences
Louisiana State University
Baton Rouge, Louisiana 70803

## LOUISIANA STATE UNIVERSITY IN NEW ORLEANS
### LAKE FRONT, NEW ORLEANS, LOUISIANA

Louisiana State University (LSU) in New Orleans is located on the shore of Lake Pontchartrain from which access to the Gulf of Mexico is afforded by the Intercoastal Waterways, the Mississippi River and connecting bayous and canals. The College of Sciences has a small vessel suitable for estuarine studies which is well equipped with field equipment supported by adequate laboratory-based facilities.

The facilities of the Marine Laboratory located on Grand Terre Island, Louisiana, may be made available upon request through cooperation with the Louisiana Wild Life and Fisheries Commission. These facilities consist of several research vessels and a land-based seawater laboratory located on the Gulf of Mexico. Similarly, the facilities and vessels of the State of Mississippi's Gulf Coast Research Laboratory, Ocean Springs, Mississippi, may be made available upon request. The facilities of the U.S. Department of the Interior at Pascagoula, Mississippi, include several fishery research vessels, and may be made available for intermittent periods through cooperative research programs. All of these locations are directly on the Gulf of Mexico within 90 miles of New Orleans.

The LSU System holds charter membership in the Gulf Universities Research Corporation, which is described in the Consortia section of this publication.

No degrees are offered in oceanography, but the bachelors degree is offered in biological sciences, chemistry, earth sciences, engineering sciences and physics; the M.S. degree is offered in biological sciences, chemistry and physics; the Ph.D. degree is offered presently in the Departments of Chemistry and Physics.

The University considers that specialization in marine science should be undertaken within one of the classical scientific disciplines such as biological sciences, chemistry, earth sciences, engineering sciences, and physics. Although undergraduate degrees are offered in these areas, graduate studies rather than undergraduate studies, are emphasized in the interdisciplinary marine sciences program. There is no separate department offering work toward a degree in oceanography. The Committee on Oceanography will assist students who wish to prepare themselves for work in this special field, and will help them arrange a joint program of study when that is desired in any of the above disciplines.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 116 | Aquatic Microbiology | 4 |
| 117 | Limnology and Oceanography | 4 |
| 143 | Advanced Vertebrate Zoology (Ichthyology) | 4 |
| 150 | General Ecology | 4 |
| 154 | Invertebrate Zoology | 4 |
| 155 | Comparative Physiology | 4 |
| 203 | Malacology | 3 |

DEPARTMENT OF EARTH SCIENCES

| | | |
|---|---|---|
| 181 | Introduction to Geophysics | 3 |
| 182 | Earth Physics | 3 |
| 185 | Introduction to Oceanography | 3 |

The instructional staff for the courses listed above consists of the following:

Bartell, C. K., Ph.D., Assistant Professor, Biological Sciences
Dundee, D. S., Ph.D., Professor, Biological Sciences
Irwin, R. J., Ph.D., Assistant Professor, Biological Sciences
Poirrier, M.A., Ph.D., Assistant Professor, Biological Sciences
Snoden, J. O., Ph.D., Assistant Professor, Earth Sciences
Weidie, A. E., Ph.D., Associate Professor, Earth Sciences
Wolleben, J. A., Ph.D., Assistant Professor, Earth Sciences

To obtain further information, address all inquiries directly to:

Dr. Michael A. Poirrier
Chairman (Acting), Committee on

Oceanography
College of Sciences
Louisiana State University in New Orleans
Lake Front, New Orleans, Louisiana 70122

## UNIVERSITY OF MAINE
ORONO, MAINE

The University offers marine science courses both at the Orono campus and at the marine research station, the Ira C. Darling Center for Research, Teaching and Service, at Walpole. Facilities at Orono include classrooms and laboratories in the Departments of Bacteriology, Botany and Plant Pathology, Geological Sciences, and Zoology, and IBM 360-30 and IBM 1800 computers. At Walpole, 100 miles south of Orono, facilities on a 136-acre site include a classroom, research laboratories, access terminal for the Orono computing equipment, library, year-round accommodations for students, two 34-foot research vessels, small craft and waterfront facilities. Open ocean research capability is provided by cooperative use of vessels at other institutions.

The following degree is offered by the Department of Oceanography*:

1. Ph.D. in Oceanography. Required courses are Oc 201, 220, 240, 260, and 391. All students must also obtain research experience at sea, pass written and oral comprehensive examinations, demonstrate reading knowledge of two foreign languages, and complete and defend a research dissertation.

*A M.S. in Oceanography is pending.

The following courses are offered in conjunction with the above program:

DEPARTMENT OF MICROBIOLOGY

| | | |
|---|---|---|
| Mb 201 | Marine Microbiology | 3 |

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

| | | |
|---|---|---|
| Bt 163 | Introduction to Phycology | 4 |

DEPARTMENT OF GEOLOGICAL SCIENCES

| | | |
|---|---|---|
| Gy 218 | Low Temperature-Pressure Geochemistry | 3 |
| Gy 221 | Sedimentology | 3 |
| Gy 226 | Micropaleontology (same as Oc 226) | 4 |
| Gy 241 | Glacial Geology | 3 |
| Gy 242 | Quartenary Environments and Climatic Change | 3 |
| Gy 260 | Marine Geology (same as Oc 260) | 3 |
| Gy 264 | Structure and Tectonics of the Seafloor (same as Oc 264) | 3 |

DEPARTMENT OF OCEANOGRAPHY

| | | |
|---|---|---|
| Oc 170 | Introduction to Oceanography | 3 |
| Oc 201 | Biological Oceanography | 3 |
| Oc 208 | Anatomy and Classification of Fishes | 5 |
| Oc 210 | Marine Invertebrate Zoology | 5 |
| Oc 260 | Marine Geology | 3 |
| Oc 264 | Structure and Tectonics of the Seafloor | 3 |
| Oc 393 | Problems in Biological Oceanography | Arr. |
| Oc 399 | Graduate Thesis | |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| Zo 168 | Limnology | 4 |
| Zo 170 | Introduction to Oceanography (same as Oc 170) | 3 |
| Zo 171 | Fishery Biology | 4 |
| Zo 201 | Biological Oceanography (same as Oc 201) | 3 |
| Zo 208 | Anatomy and Classification of Fishes (same as Oc 208) | 5 |
| Zo 210 | Marine Invertebrate Zoology (same as Oc 210) | 5 |
| Zo 232 | Ichthyology | 4 |
| Zo 292 | Functional Anatomy of Marine Invertebrates | 3 |
| Zo 357 | Population Dynamics | 2 |
| Zo 362 | Estuarine Ecology | 4 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

Vadas, Robert L., Ph.D., Assistant Professor of Botany, Assistant Professor of Oceanography, and Assistant Professor of Zoology

DEPARTMENT OF GEOLOGICAL SCIENCES

Borns, Harold W. Jr., Ph.D., Professor of Geological Sciences
Denton, George H., Ph.D., Associate Professor of Geological Sciences
Hall, Bradford A., Ph.D., Associate Professor of Geological Sciences
Norton, Stephen A., Ph.D., Assistant Professor of Geological Sciences
Osberg, Philip H., Ph.D., Professor and Head, Department of Geological Sciences

DEPARTMENT OF MICROBIOLOGY

Pratt, Darrell E., Ph.D., Professor and Chairman, Department of Microbiology and Professor of Zoology

DEPARTMENT OF OCEANOGRAPHY

Dean, David, PH.D., Professor and Acting Head, Department of Oceanography and Professor of Zoology
DeWitt, Hugh H., Ph.D., Assistant Professor of Oceanography and Assistant Professor of Zoology
Fink, L. Kenneth, Jr., Ph.D., Assistant Professor of Oceanography and Assistant Professor of Geological Sciences
Green, Edward J., Ph.D., Associate Professor of Oceanography and Associate Professor of Geological Sciences
Hidu, Herbert, Ph.D., Assistant Professor of Oceanography and Assistant Professor of Zoology
Mazurkiewicz, Michael, Ph.D., Assistant Professor of Oceanography and Assistant Professor of Biology, UMP-G
McAlice, Bernard J., Ph.D., Assistant Professor of Oceanography and Assistant Professor of Zoology
Schnitker, Detmar F., Ph.D., Assistant Professor of Oceanography and Assistant Professor of Geological Sciences

DEPARTMENT OF PLANT AND SOIL SCIENCES

Lotse, Erik G., Agronomie Licentiat Associate Professor of Soil Chemistry

DEPARTMENT OF ZOOLOGY

Dearborn, John H., Ph.D., Associate Professor of Zoology and Associate Professor of Oceanography
Gregory, Richard W., Ph.D., Assistant Professor of Zoology
Hatch, Richard W., Ph.D., Assistant Professor of Zoology
McCleave, James D., Ph.D., Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

The Dean of the Graduate School
University of Maine
Orono, Maine 04473

## THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK
NEW YORK, NEW YORK

The College offers marine science courses at its main campus at Fort Schuyler as well as aboard the training ship, the EMPIRE STATE IV. The five-story Science Wing (Marvin Hall) in the new Science and Engineering Building accommodates the various laboratories of the College's Science Department. The Digital Computer Laboratory on the first floor is equipped with an IBM-1130 Digital Computer (including a card-reader-punch and a printer), key punches, card sorter, and various types of desk calculators.

The two-story Nuclear Reactor Laboratory and the Advanced Physics Laboratory on the first floor are designed for experiments in Atomic, Nuclear, and Reactor Physics. The facilities of the Nuclear Reactor Laboratory include a Nuclear Reactor Simulator that reproduces the control and operation functions of a nuclear power reactor, a sub-critical water-moderated reactor assembly loaded with 6,000 pounds of natural uranium which permits experimental studies of neutrons and their properties, a neutron pulse generator, a neutron howitzer, a gamma ray spectrometer, a multichannel analyzer with linear display, and a variety of nuclear radiation detection and counting equipment.

The Meteorology Laboratory, Weather Station and lecture area occupy the entire top floor. The roof is designed as a b-servation deck and provides instrumentat-on and facilities for the instruction of an entire class in recording weather data. A 40-foot steel tower supports weather instruments which read out to indicators in the classroom and laboratory. Teletype and facsimile machines provide weather data from all of North America and ships at sea. Students plot and analyze weather maps and prepare forecasts.

The R. J. Reynolds Planetarium in the fort houses the model A-1 Spitz projector. A series of three-dimensional models is used to explain the intrinsic structure of the universe as well as its apparent configuration to a terrestrial observer.

An Astronomical Observatory on the roof of the fort was completed in July 1965. The 16-foot 6-inch true hemispherical dome is electrically controlled, while the transverse shutters, offering a 48-inch clear opening, are operated through a torque converter. Both visual and photographic work can be pursued at the observatory.

The EMPIRE STATE IV, a modified C-3, has accommodations for 340 cabin passengers and 740 troops. The 12,000-ton ship is 489 feet in length, with a beam of 69 feet. Her geared steam turbine develops 8,500 horsepower and a cruising speed of 16 knots.

During the academic year, the training ship is berthed at Fort Schuyler. Facilities are available on board for laboratory sessions in marlinspike seamanship, marine engineering, communications, and electronic aids to navigation. During the summer months, the ship is steamed on the annual training sessions across the Atlantic.

The Oceanography Laboratory aboard the EMPIRE STATE IV offers students the opportunity during the summer Atlantic cruises to utilize deep sea oceanographic gear. Instruction is provided in the use of: Nansen bottles, reversing thermometers, bathythermographs, infrared thermometers, inductive salinometers, current meters, and turbidity meters, as well as radiosonde and pilot balloon instrumentation.

The 600-foot College Pier provides convenient and adequate docking space for the EMPIRE STATE IV. A boat shed adjacent to the pier is used to house and to launch and retrieve the small boats. A tidal gauge station is situated close to the pier. The basin inshore of the pier is used for mooring the racing sloops and recreational sailing craft of the College.

The course of studies in the Meteorology and Oceanography curriculum includes the practical and theoretical nautical training prerequisite for licensed deck officers together with a complete series of courses designed to provide a thorough understanding of the fundamental principles underlying the sciences of meteorology and oceanography. Combined with the professional work, cadets will pursue courses in the humanities and social sciences that are of importance in the liberal education of youth.

Theory and practice are integrated by relating the scholastic efforts of the academic year to those of the Summer Sea Training Period on the college training ship during the summer months.

The cadets who successfully complete the courses required by this curriculum receive the degree of Bachelor of Science (Meteorology and Oceanography) and, after passing the required U.S. Coast Guard examinations, a Federal license as Third Mate in the Merchant Marine, and if acceptable can obtain a commission as Ensign in the U.S. Naval Reserve.

The curriculum for cadets majoring in Marine Nuclear Science includes an extensive preparation in mathematics, physics, chemistry, and metallurgy as well as in the humanities and social studies. The complete set of courses is designed to establish a firm foundation for a professional career in the immediate and foreseeable future. The individual courses have been designed to prepare cadets for the professional duties involved in operation, research and development of nuclear energy, as well as to prepare them in the necessary practical nautical training required to become licensed ship officers.

Cadets who successfully complete the course of studies in this major receive the registered and accredited degree of Bachelor of Science (Marine Nuclear) and are eligible to take the Third Engineer's U.S. Coast Guard operating engineer's license examination; and if acceptable to the U.S. Navy,

they can obtain an Ensign's commission in the U.S. Naval Reserve.

The following courses are offered in conjunction with the above programs:

METEOROLOGY

| | | |
|---|---|---|
| 202 | General Meteorology | 3 |
| 305 | Synoptic Meteorology I | 3 |
| 306E | Synoptic Meteorology II | 3 |
| 310 | Dynamic Meteorology I | 3 |
| 311 | Meteorology for Mariners | 3 |
| 411 | Dynamic Meteorology II | 3 |
| 422E | Weather Forecasting | 3 |
| 423E | Thesis | |
| 432E | Applied Meteorology | 3 |
| 442E | Research | |
| 452 | Instruments | 3 |
| 454 | Meteorological Observations | 1 |

OCEANOGRAPHY

| | | |
|---|---|---|
| 303 | General Oceanography I | 3 |
| 304E | General Oceanography II | 3 |
| 305 | Oceanographic Instruments | 3 |
| 406 | Applied Oceanography | 3 |
| 410E | Oceanography | 3 |
| 413 | Dynamic Oceanography I | 3 |
| 414E | Dynamic Oceanography II | 3 |

The College also offers undergraduate programs in ocean engineering and the training of seagoing officers which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF SCIENCE

Bouscher, Meyer, M.S., Instructor of Mathematics
Cifichiello, Vito, M.S., Associate Professor of Physics
Degani, Meir H., Sc.D., Chairman and Professor of Physics
Epstein, David, Ph.D., Associate Professor of Oceanography
Gambler, Leonard C., M.A., Assistant Professor of Mathematics
Hess, Fred C., Ed.D., Professor of Chemistry
Kinney, Alvin E., Ed.D., Executive Officer and Professor of Mathematics
Liverhant, Salomon E., M.S., Professor of Physics
Longobardi, Joseph D., M.S., Associate Professor of Physics
McGinn, George, Ph.D., Assistant Professor of Physics
Pescatore, Joseph J., Ph.D., Assistant Professor of Chemistry
Rich, Ellis J., M.S., Instructor of Mathematics
Schwartz, Jay R., M.A., Assistant Professor of Mathematics
Teofilo, Vincent L., MNE, Instructor of Physics
Thor, Charles, M.S., Professor of Meteorology
Tolchin, Stephen G., M.S., Instructor of Physics
Vierno, Joseph D., Jr., Manager of Digital Computer Laboratory
Zemel, Hersh, M.S., Assistant Professor of Meteorology

To obtain further information, address all inquiries directly to:

Dr. M. H. Degani
Chairman, Science Department
State University of New York
Maritime College
Fort Schuyler
New York, New York 10465

## UNIVERSITY OF MARYLAND
### COLLEGE PARK, MARYLAND

Marine facilities exist in the Chesapeake Biological Laboratories for work in Chesapeake Bay. Tropical Marine Botany is carried out on the reefs of the Caribbean in cooperation with the Department of Marine Sciences of Puerto Rico. Students are urged to expand their training by summer study at the Marine Biological Laboratory at Woods Hole, Massachusetts.

The Department of Botany offers broad training and intensive specialization in genetics, molecular biology, physiology, biochemistry, biophysics, ecology, taxonomy, anatomy--morphology, mycology, pathology, virology, nematology, phycology, marine biology.

The Master of Science and Doctor of Philosophy degrees require a solid background in mathematics, chemistry, physics, and the other biological sciences; however, each student's program is designed for specialization within the field, and there is considerable flexibility with regard to specific course preparation. The Graduate Record Examination is not required. The selection process relies primarily on the student's prior academic record and communications from professors in his previous curriculum.

The following degrees are offered:

1. M.S. in Botany (Specialty in Marine Botany). The Master of Science degree is awarded for successful completion of a minimum of 30 hours of advanced study beyond the undergraduate level. The student must declare a major subject field and a minor subject field. Twelve to 15 credit hours will be in the major area and nine to 12 hours, depending upon the number in the major area, will be in the minor field. Supportive courses are selected from other departments for those whose interest is Marine Biology. A thesis is required.

2. Ph.D. in Botany (Specialty in Marine Botany). The candidate must select an area of major emphasis and one or two areas of minor emphasis. Each candidate must take certain background tests, and must successfully pass the following academic examinations; a six-hour preliminary examination taken relatively early in the program, a final written comprehensive examination covering the entire graduate course of study, and a final oral or written examination directed primarily toward the research project. A thesis is required.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BOTANY

| | | |
|---|---|---|
| 102 | Plant Ecology | 2 |
| 113 | Plant Geography | 2 |
| 128 | Mycology | 4 |
| 161 | Systematic Botany | 2 |
| 171 | Marine Plant Biology | 4 |
| 172 | Special Problems in Marine Research | 1-3 |
| 209 | Physiology of Algae | 2 |
| 210 | Physiology of Algae Laboratory | 1 |



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| | | |
|---|---|---|
| 216 | Nucleic Acids and Molecular Genetics | 2 |
| 219 | Advanced Plant Ecology | 3 |
| 221 | Plant Virology | 2 |
| 223 | Physiology of Fungi | 2 |
| 227 | Physiology of Pathogens and Host-Pathogen Relationships | 3 |
| 230 | Advanced Plant Physiology | 2 |
| 231 | Plant Biochemistry | 2 |
| 232 | Plant Biophysics | 2 |
| 301 | Special Problems in Marine Botany | 1-3 |

Undergraduate students may take 100 level courses.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BOTANY

Brown, Russell G., Associate Professor
Corbett, M. Kenneth, Professor
Galloway, Raymond A., Professor
Karlander, Edward P., Associate Professor
Krauss, Robert W., Professor and Head of Department
Motta, Jerome J., Assistant Professor
Morgan, Delbert T., Jr., Professor
Patterson, Glenn W., Associate Professor
Rappleye, Robert D., Associate Professor
Reveal, James L., Assistant Professor
Sorokin, Constantine, Research Professor
Terborgh, John, Assistant Professor

To obtain further information, address all inquiries directly to:

Dr. Robert W. Krauss
Head, Department of Botany
University of Maryland
College Park, Maryland 20742

## MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS

The graduate program in oceanography is conducted jointly by M.I.T. and the Woods Hole Oceanographic Institution. Three departments in the School of Science at M.I.T. -- those of Earth and Planetary Sciences, Meteorology, and Biology -- are involved in instruction in physical oceanography, marine geology, marine geophysics, marine chemistry and geochemistry, and biological oceanography. Each student has a primary affiliation with one of the three departments.

M.I.T. provides instruction in many fields of science, engineering and the humanities, as well as laboratories, libraries, and computer and data processing services; additionally, a small research boat which is used for local observations and for instrument testing is docked at the M.I.T. facility at Lewis Wharf in Boston. W.H.O.I. brings to the program a large scientific staff involved in many phases of oceanography, along with extensive laboratory facilities on shore and a fleet of seagoing ships devoted to research and instruction. Students may take courses simultaneously at both institutions, and transportation between the two campuses is provided. Thesis research may be undertaken at either institute, the locations of the thesis advisor and the needed facilities usually being the determining factors. (For further information on the joint program, please refer to the description in this publication prepared by the Woods Hole Oceanographic Institution.)

All M.I.T. doctoral candidates in oceanography are considered to be in the joint program and are awarded a joint degree of Ph.D. or Sc.D. in Oceanography. (No distinction is made between the two and a student may choose whichever seems more appropriate to him.) In the first phase of the doctoral program, the student prepares himself for the General Examination in the field of his degree; after successfully passing this, he enters the second phase, that of thesis research. The successful defense of a thesis of high quality marks the completion of the program.

The degree of Master of Science is awarded only by M.I.T. Minimum requirements are the completion of an approved program of 66 units, of which at least 42 must be graduate "A" subjects (advanced graduate subjects indicated as such in the catalogue), and the presentation of an acceptable thesis.

All applicants to the graduate program should have a strong background in basic mathematics and physics; chemistry is required for students of marine chemistry and biological oceanography while geology is needed for marine geology.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 12.21 | Physical Oceanography | 12 |
| 19.83 | Physical Oceanography I | 12 |

GRADUATE COURSES

| | | |
|---|---|---|
| 1.69 | Waves and Coastal Processes (A) | 9 |
| 1.70 | Mechanics of Sediment Transport (A) | 6 |
| 2.283 | Fluid Physics of Pollution (A) | 12 |
| 6.573 | Introduction to Random Processes (A) | 12 |
| 7.23 | Microbial Physiology (A) | 12 |
| 7.25 | Topics in Virology (A) | 8 |
| 7.41 | Biological Oceanography (A) | 9 |
| 7.71 | Biophysical Chemistry (A) | 6 |
| 7.72 | Advanced Biochemistry (A) | 12 |
| 12.70 | Introduction to Physical Oceanography | 9 |
| 12.72 | Marine Geology (A) | 10 |
| 12.73 | Marine Geodesy (A) | 9 |
| 12.74 | Marine Geophysics (A) | 9 |
| 12.81 | Waves and Tides (A) | 12 |
| 12.812 | Physical Properties of Sea Water (A) | 9 |
| 12.83 | Chemical Oceanography (A) | 9 |
| 12.84 | Marine Chemistry (A) | 9 |
| 18.308 | Wave Motion (A) | 12 |
| 18.356 | Rotating Fluids (A) | 12 |
| 18.358 | Hydrodynamic Stability and Turbulence (A) | 12 |
| 19.22 | Air and Sea Instruments (A) | 11 |
| 19.24 | Fluid Dynamics Laboratory (A) | 10 |
| 19.61 | Introduction to Dynamical Meteorology (A) | 12 |
| 19.65 | Turbulence and Random Phenomena in Fluid Mechanics (A) | 9 |
| 19.67 | Planetary Fluid Dynamics (A) | 12 |
| 19.68 | Waves in Oceans and Atmospheres (A) | 12 |
| 19.80 | Surface and Internal Waves (A) | 9 |
| 19.81 | Introduction to Oceanic Models (A) | 9 |

| | | |
|---|---|---|
| 19.82 | Introduction to Oceanic Models (A) | 9 |
| 19.84 | Dynamic Oceanography (A) | 9 |
| 19.86 | Ocean Circulations (A) | 9 |
| 19.88 | Oceanic Variability (A) | 9 |

In addition, there are often seminars in current topics. Reading courses and "special problems" courses may be arranged between a student and a staff member.

The Institute also offers undergraduate, graduate and professional programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF EARTH AND PLANETARY SCIENCES

Edmond, John M., Ph.D., Assistant Professor of Oceanography
Frey, Frederick A., Ph.D., Assistant Professor of Geochemistry
Press, Frank, Ph.D., Head of Department and Professor of Geophysics
Simmons, M. Gene, Ph.D., Professor of Geophysics
Southard, John B., Ph.D., Assistant Professor of Geology
Wunsch, Carl I., Ph.D., Associate Professor of Oceanography

DEPARTMENT OF METEOROLOGY

Beardsley, Robert C., Ph.D., Assistant Professor of Oceanography.
Charney, Jule G., Ph.D., Professor of Meteorology
Houghton, Henry G., S.M., Professor of Meteorology
Keily, Delbar P., S.B., Associate Professor of Meteorology
Mollo-Christensen, Erik L., Sc.D., Professor of Meteorology
Phillips, Norman A., Ph.D., Head of Department and Professor of Meteorology
Rhines, Peter B., Ph.D., Assistant Professor of Oceanography
Starr, Victor P., Ph.D., Professor of Meteorology
Stommel, Henry M., B.S., Professor of Oceanography

DEPARTMENT OF BIOLOGY

Holt, Charles E., III, Ph.D., Associate Professor of Biology
Luria, Salvador E., M.D., D.Sc., Institute Professor of Biology
Magasanik, Boris, Ph.D., Head of Department and Professor of Microbiology
Rich, Alexander, M.D., Professor of Biophysics

To obtain further information, address all inquiries directly to:

Joint Program in Oceanography
Massachusetts Institute of Technology
Room 54-912
Cambridge, Massachusetts 02139

OR

Woods Hole Oceanographic Institution
Woods Hole
Massachusetts 02543

## UNIVERSITY OF MASSACHUSETTS
### AMHERST, MASSACHUSETTS

The University offers marine sciences courses at the Amherst campus and individual research opportunities at the Gloucester Marine Station. The Master of Science in Marine Sciences is administered by the Marine Sciences Council through graduate faculty from appropriate departments. The Council is supported by and is responsible to the Graduate School. The Gloucester Marine Laboratory is also administered by the Dean of the Graduate School. The Marine Sciences Program crosses disciplinary lines and ties together the marine interests in botany, geology, microbiology and zoology with the applied fields of fisheries biology and food sciences and technology. The basic sciences are housed in the multi-building Morrill Science Center; the fisheries section occupies part of the Holdsworth Natural Resources Center and food sciences and technology is housed in the recently build Chenoweth Hall. Students on the Amherst campus may participate in The Five College Community sharing the facilities of Amherst, Smith, Mt. Holyoke and Hampshire Colleges. In June 1970, the University acquired property for a marine station at Hodgkin's Cove in Gloucester on the north shore of Cape Ann. The first building is now being renovated as a research laboratory and additional teaching-research facilities are planned. Dockage for vessels up to 160 feet is now available at Hodgkin's Cove and at nearby Gloucester, and fishing vessels are available for charter for research and teaching. Assorted small craft are already available for inshore and estuarine studies.

The University offers the following degrees:

1. Master of Science in Marine Sciences. Students seeking this degree should have a science background including chemistry, physics and introductory calculus in addition to a major in one of the basic or applied sciences. This degree program is intended to prepare students for further graduate work or for employment in marine-related government or industrial positions. Some students with exceptional liberal arts backgrounds may use this degree for training in a new field.

Students are admitted to the Graduate School via the interdisciplinary Marine Sciences Program (equal to a graduate department) with the approval of the department of the student's chosen specialty option. Students are required to take a broad oceanographic core curriculum of three courses: Physical Oceanography (Geology 655), Geological Oceanography (Geology 752) and Biological Oceanography (Marine Sciences 501). Fifteen credits will be required in the chosen specialty option: botany, geology, or zoology. A student will demonstrate oceanographic research abilities through the completion of either a six to eight hour special problem or a thesis. Shipboard experience on board R/V EASTWARD (Marine Sciences 700) or its equivalent is strongly recommended. A student must pass a comprehensive written examination upon the core curriculum content and a qualifying examination if re-

quired by the department of his specialty option; he will not, however, be expected to demonstrate the breadth of the normal departmental major in the specialty. Option courses are arranged with consent between the Program and the Department. At least six hours of 700-900 level courses are required. Language examinations requirements follow those of the department of the option.

2. Doctor of Philosophy in Botany, Geology, Microbiology, and Zoology. As yet there is no doctoral program in oceanography at the University but students may be admitted into the regular doctoral programs of the various departments participating in the Marine Scicence Program and receive a marine-oriented doctoral degree. Many faculty in each of these departments are currently involved in marine research and in graduate education. Guidance committees are often composed of faculty crossing departmental lines which permits flexibility in the preparation of these students. Language requirements and course requirements vary between departments and specific requirements can be obtained by consulting the current Graduate School Bulletin.

The following courses are offered in conjunction with the above programs:

GRADUATE COURSES

MARINE SCIENCES PROGRAM

| | | |
|---|---|---|
| MS 501 | Biological Oceanography | 3 |
| MS 525 | Introductory Oceanography | 3 |
| MS 550 | Microbial Ecology of Marine Environment | 2 |
| MS 700 | Special Problems in Oceanographic Techniques | 1 |

GEOLOGY

| | | |
|---|---|---|
| 655 | Physical Oceanography | 3 |
| 666 | Pleistocene Geology | 3 |
| 670 | Geophysics | 3 |
| 716 | Geochemistry | 3 |
| 723 | Sedimentary Petrology | 3 |
| 745 | Paleoecology | 2 |
| 751 | Sedimentation | 3 |
| 752 | Geological Oceanography | 3 |
| 756 | Coastal Processes | 2 |
| 771 | Physics of the Earth | 3 |
| 772 | Advanced Geophysical Interpretation Techniques | 3 |
| 782 | Petroleum Geology | 3 |
| 846 | Cenozoic Stratigraphy | 3 |

BOTANY

| | | |
|---|---|---|
| 521 | Plant Ecology | 3 |
| 522 | Autecology | 3 |
| 528 | Genecology | 3 |
| 531 | General Mycology | 3 |
| 541 | Phycology | 3 |
| 561 | Biology of Lower Plants | 4 |
| 721 | Advanced Plant Ecology | 3 |
| 731 | Advanced Mycology | 3 |
| 741 | Advanced Phycology | 3 |
| 750 | Plant Photosynthesis | 3 |

ZOOLOGY

| | | |
|---|---|---|
| 575 | Biology of Protozoa | 3 |
| 581 | Biology of Lower Invertebrates | 3 |
| 582 | Biology of Higher Invertebrates | 3 |
| 583 | General Parasitology | 3 |
| 600 | Vertebrate Zoology | 3 |
| 602 | Ichthyology | 3 |
| 635 | Limnology | 3 |
| 637 | Ecology | 3 |
| 666 | Vertebrate Physiology | 4 |
| 670 | Comparative Physiology | 4 |
| 740 | Advanced Invertebrate Zoology | 3 |
| 744 | Metazoan Symbiosis | 3 |
| 755 | Systematics and Evolutionary Mechanisms | 3 |
| 757 | Population and Community Ecology | 3 |

The University also offers graduate programs in Ocean Engineering and Fisheries Biology which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

MARINE SCIENCES PROGRAM

Gentile, Arthur C., Ph.D., Chairman, Marine Sciences Council
Gilfillion, Edward, Ph.D., Post-doctoral, Gloucester Laboratory
Sears, James, Ph.D., Post-doctoral, Gloucester Laboratory
Yentsch, Charles S., M.S., Professor of Biological Oceanography, Director of Gloucester Laboratory

BOTANY DEPARTMENT

Bigelow, Howard E., Ph.D., Associate Professor of Botany
Fultz, Sara A., Ph.D., Assistant Professor of Botany
Gentile, Authur C., Ph.D., Professor of Botany, Associate Dean of Graduate School, Chairman, Marine Sciences Council
Mulcahy, David L., Ph.D., Assistant Professor of Botany
Wilce, Robert T., Ph.D., Associate Professor of Botany

GEOLOGY

Bromery, R. W., Ph.D., Professor of Geophysics
Hartshorn, Joseph H., Ph.D., Professor of Geology
Hayes, Miles O., Ph.D., Associate Professor of Geology
Jaffe, Howard W., B.A., Associate Professor of Geology
Pitrat, Charles W., Ph.D., Associate Professor of Geology
Webb, Gregory W., Ph.D., Associate Professor of Geology

ZOOLOGY

Anderson, Everett, Ph.D., Professor of Zoology
Andrews, Thomas J., M.S., Associate Professor of Zoology
Edward, D. Craig, Ph.D., Assistant Professor of Zoology
Honigberg, Bronislaw, Ph.D., Professor of Zoology
Ludlum, Stuart D., Ph.D., Associate Professor of Zoology
Nutting, William B., Ph.D., Professor of Zoology
Potswald, Herbert E., Ph.D., Assistant Professor of Zoology
Roberts, John L., Ph.D., Professor of Zoology
Roberts, Larry S., Ph.D., Associate Professor of Zoology

To obtain further information, address all inquiries directly to:

Chairman, Marine Sciences Program
Munson Hall
University of Massachusetts
Amherst, Massachusetts 01002

## ROSENSTIEL SCHOOL OF MARINE AND ATMOSPHERIC SCIENCE UNIVERSITY OF MIAMI
### MIAMI, FLORIDA

The geographical location of the Rosenstiel School of Marine and Atmospheric Science is unique in many important aspects. The Gulf Stream brings to Miami an essentially tropical environment and offers itself as an ideal object for mass transport studies. Coral reefs grow vigorously off the Florida Keys, providing a living laboratory for the study of numerous species and ecological relationships. The Florida-Bahamas carbonate platform, the easily accessible Gulf of Mexico, Caribbean Sea, and the Antillean Island Arc are some of many geological features of the region which are of great interest to geologists and geophysicists. The Everglades-Florida Bay ecological system provides a natural laboratory for the study of marine organisms important to Fishery Sciences. More of the world ocean is closer to Miami than to any other location within the continental United States.

The School's largest building, named for Gilbert Hovey Grosvenor, is three stories high and consists of three joined wings. Housed there are the greater part of the research laboratories, lecture rooms, labor tory classrooms, computer facilities, and administrative offices. The research laboratories are well equipped for many facets of science, including radiation detection; tritium measurements; carbon 14, potassium-argon, and uranium-thorium dating; mass spectrometry; x-ray diffraction; optical spectroscopy; atomic absorption; and electron microscopy. Also located in the Grosvenor Building are the biological museum, which houses a collection of more than 300,000 marine fishes, invertebrates, and plants from many areas of the world, and the library which holds more than 24,000 volumes and 21,000 reprints.

The Alfred C. Glassell, Jr. Building is a unique, controlled environmental laboratory utilized for biological research on marine animals, ranging in size from protozoa to sharks. Within its walls, it is possible to reproduce and maintain natural or artificial environments, controllable in such parameters as temperature, salinity, turbidity, and pH. The Agassiz and Collier Buildings house additional research laboratories and work areas for students and staff requiring circulating seawater aquaria for their experiments. Various service buildings, storage facilities for radioisotopes and deep-sea cores, and a small dormitory complete the present physical plant.

The School has initiated construction of the Henry L. Doherty Marine Science Center, which will provide central library services, an auditorium, conference rooms, and dining facilities for the entire Virginia Key oceanographic complex. The Virginia Key Oceanographic complex is comprised of the International Oceanographic Foundation, the Miami Seaquarium, the Bureau of Commerical Fisheries' Tropical Atlantic Biological Laboratory (National Oceanic and Atmospheric Administration), and the Miami-Dade Junior College Marine Science Technology Center.

The School of Marine and Atmospheric Sciences' Radar Meteorological Laboratory and Division of Atmospheric Sciences are presently located on the University's Main Campus. In addition, facilities of the various schools and departments within the University are available to the researchers and students of the school.

Other off-campus stations include Fisher Island (15 acres with several buildings), largely dedicated to comparative sedimentology; and a 45-mile underwater acoustic range from Miami to Bimini, with a large sound source in waters off Fowey Rock Lighthouse. The Pigeon Key facility is located 112 miles south of the main campus in the Florida Keys with laboratory and living space for studies in aspects of marine biology, calcium carbonate deposition and mangrove ecology. An experimental nursery for pink shrimp and pompano has been established at the Florida Power and Light Company's Turkey Point Plant.

Ocean going laboratories are maintained by the school aboard three major research vessels and several small craft. The largest vessel, R/V JOHN ELLIOT PILLSBURY, is 176 feet long and carries 14 scientists and a crew of 22 and has air-conditioned laboratories and living spaces. PILLSBURY is completely equipped for collection and analysis of samples and specimens by scientists at sea. She has both wet and dry laboratories, a deep sea trawling winch with a capacity of 42,000 pounds, deep sea coring apparatus, two hydrographic winches, and a bathythermograph winch. Her electronic equipment consists in part of a navigational center with dual radar sets, a precision depth recorder for deep ocean echo sounding, LORAN and complete radio equipment with high and low frequency transmission and receiving capabilities.

R/V GERDA is 78 feet long and has berths for eight scientists and a crew of five. She is equipped with wet and dry laboratories as well as trawling, hydrographic, and bathythermograph winches. Her precision navigational instruments include Hi-Fix radio navigation, a precision depth recorder, a radio direction finder, radar, and radio telephone.

The R/V CALANUS, commissioned on 21 September 1970, is 62 feet 9 inches in length, with a beam of 20 feet and a molded depth of 8 feet 8 inches. Electronic equipment includes depth recorders, radio telephone, radar, and radio detection finder. CALANUS has a combination wet/dry laboratory completely air-conditioned, adjoining a 400 square foot working after deck on which a double drum hydraulic winch is mounted. Accommodations are available for six scientists, the captain, and a crew member. The R/V CALANUS will be used for training graduate students in methods of carrying out research at sea, and for various scientific investigations on the Straits of Florida, Bahama Banks, and Florida Keys.

The following degrees are offered:

1. M.S. degrees are offered in Marine Biological Science, Marine Geology and Geophysics, Physical Oceanography, Chemical Oceanography, and Atmospheric Sciences. All students are required to complete 30

credits and a thesis representing original research or critical review of literature on a topic approved by the staff. In most cases an examination demonstrating the reading knowledge of a foreign language (French, German, or Russian) and a comprehensive examination covering a general understanding of the major field as well as courses taken is required.

2. Ph.D. degrees are offered in Marine Biological Sciences, Marine Geology and Geophysics, Physical Oceanography, Chemical Oceanography, and Atmospheric Sciences. All students are required to obtain permission from their advisory committee and petition the Academic Faculty of the School to enter the Ph.D. program. The student must spend at least two consecutive semesters beyond the first year's graduate work in full-time study at the University of Miami's School of Marine and Atmospheric Science.

At least 36 graduate credits in courses and seminar are required (these may include courses taken for the M.S. Degree, excluding thesis credits), plus 24 credits for the Dissertation. Up to 12 credits may be transferred from other institutions if approved. In most cases a reading knowledge of two languages and a qualifying examination is required.

The following courses are offered in conjunction with the above programs:

ATMOSPHERIC SCIENCE

| | | |
|---|---|---|
| ATM 500 | Introduction to Planetary Fluid Dynamics | 2 |
| ATM 501 | Atmospheric Electricity | 3 |
| ATM 511 | Geophysical Fluid Dynamics I | 3 |
| ATM 518 | Theory of Sensors and Systems | 3 |
| ATM 531 | Physical Meteorology | 3 |
| ATM 532 | Radar Meteorology | 3 |
| ATM 551 | Introduction to Atmospheric Science | 3 |
| ATM 601-604 | Seminar in Atmospheric Science | 1 |
| ATM 605-608 | Research | 2-4 |
| ATM 611 | Geophysical Fluid Dynamics II | 3 |
| ATM 631 | Air-Sea Interaction | 3 |
| ATM 641 | Tropical Meteorology | 3 |
| ATM 642 | Problems in Applied Tropical Meteorology | 2 |
| ATM 651 | Aeronomy | 3 |
| ATM 660 | Cloud Physics | 3 |
| ATM 661 | Atmospheric Structure and Dynamics I | 4 |
| ATM 662 | Computer Models in Fluid Dynamics | 4 |
| ATM 663 | Atmospheric Structure and Dynamics III | 4 |
| ATM 664 | Atomospheric Structure and Dynamics IV | 4 |
| ATM 665 | Atmospheric Structure and Dynamics V | 3 |
| ATM 670 | Selected Topics in Atmospheric Science | 3 |
| ATM 671-679 | Advanced Study in Atmospheric Science | 2-4 |
| ATM 681-687 | Special Work | 3 |

MARINE BIOLOGICAL SCIENCE

| | | |
|---|---|---|
| MBS 204 | Introduction to Marine Biology | 4 |
| MBS 404 | Advanced Marine Biology | 4 |
| MBS 586 | Fishes and their Environment | 3 |
| MBS 602 | Biological Oceanography Seminar | 1 |
| MBS 604 | General Biological Oceaongraphy | 3 |
| MBS 605 | General Biological Oceanography Laboratories | 1 |
| MBS 621 | Taxonomy of Marine Invertebrates | 4 |
| MBS 622 | Ecology of Marine Animals | 4 |
| MBS 623 | Invertebrate Embryology | 4 |
| MBS 625 | Behavior of Marine Organisms | 4 |
| MBS 630 | Marine Microbiology | 5 |
| MBS 631 | Plankton | 4 |
| MBS 632 | Phytoplankton | 4 |
| MBS 634 | Physiology of Marine Organisms | 4 |
| MBS 671-679 | Advanced Study in Marine Biological Research | 2-3 |
| MBS 681 | Marine Biological Research | 2 |
| MBS 682 | Marine Biological Research | 2 |
| MBS 687 | Systematics of Fishes | 4 |

MARINE GEOLOGY AND GEOPHYSICS

| | | |
|---|---|---|
| MGG 504 | Structural Geology | 4 |
| MGG 551 | Marine Geology | 4 |
| MGG 553 | Sedimentation | 4 |
| MGG 554 | Sedimentary Petrology | 4 |
| MGG 556 | Principles of Micropaleontology | 4 |
| MGG 558 | Geochemistry | 4 |
| MGG 561 | Geophysics | 4 |
| MGG 571 | Special Studies | 1-4 |
| MGG 581 | Supervised Projects | 2 |
| MGG 582 | Supervised Projects | 2 |
| MGG 601 | Marine Sciences Seminar | 1 |
| MGG 605 | Seminar in Marine Geology and Geophysics | 1 |
| MGG 621 | Isotopic Processes in Earth Sciences | 3 |
| MGG 622 | Analytical Methods in Geochemistry | 4 |
| MGG 652 | Carbonate Sedimentation | 3 |
| MGG 653 | Advanced Sedimentation | 4 |
| MGG 654 | Stratigraphic Micropaleontology | 4 |
| MGG 655 | Paleoecology | 3 |
| MGG 658 | Advanced Geochemistry and Mineralogy | 4 |
| MGG 661 | Tectonics | 3 |
| MGG 662 | Morphology and Structure of Ocean Basins | 3 |
| MGG 671-679 | Advanced Studies in Marine Geology and Geophysics | 2-3 |

CHEMICAL OCEANOGRAPHY

| | | |
|---|---|---|
| CHO 503 | Fundamentals of Chemical Oceanography | 3 |
| CHO 504 | Chemical Oceanography Laboratory | 1 |
| CHO 581 | Supervised Projects | 2 |
| CHO 582 | Supervised Projects | 2 |
| CHO 600 | Advanced Chemical Oceanography | 3 |
| CHO 610 | Analytical Chemistry in Oceanography | 3 |
| CHO 620 | Physical Chemical Oceanography | 3 |
| CHO 630 | Oceanic Chemical Oceanography | 3 |
| CHO 640 | Selected Problems of Chemical Oceanography | 4 |
| CHO 660 | Atmospheric Chemistry | 3 |
| CHO 670 | Chemical Oceanography Seminar | 1 |
| CHO 680-690 | Special Topics in Marine Chemistry | 2 |

PHYSICAL OCEANOGRAPHY

| | | |
|---|---|---|
| PHO 201 | Introduction to Oceanography | 3 |
| PHO 202 | Ocean and Laboratory Studies in Oceanography | 1 |
| PHO 500 | Introduction to Planetary Fluid Dynamics | 2 |
| PHO 501 | Physical Oceanography | 3 |

| | | |
|---|---|---|
| PHO 502 | Laboratory for Physical Oceanography | 1 |
| PHO 503 | Physical Oceanography | 3 |
| PHO 504 | Laboratory for Physical Oceanography | 1 |
| PHO 511 | Geophysical Fluid Dynamics I | 3 |
| PHO 581 | Supervised Projects | 2 |
| PHO 582 | Supervised Projects | 2 |
| PHO 602 | Physical Oceanography Seminar | 1 |
| PHO 611 | Geophysical Fluid Dynamics II | 3 |
| PHO 612 | Topics in Dynamical Oceanography | 3 |
| PHO 613 | Waves and Tides | 3 |
| PHO 614 | Optical Oceanography | 3 |
| PHO 671-679 | Advanced Studies in Physical Oceanography | 2-3 |

The University also offers graduate programs in Ocean Engineering, Ocean Law, and Fishery Science which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DIVISION OF ATMOSPHERIC SCIENCES

Estoque, Mariano, Ph.D., Professor
Geisler, John, Ph.D., Associate Professor
Gerrish, Harold, M.S., Assistant Professor
Herrera-Cantilo, Luis, B.S.C.E., Research Scientist
Kraus, Eric B., Ph.D., Chairman and Professor
Latham, Donald, Ph.D., Assistant Professor
Senn, Harry, M.S., Associate Professor
Van de Boogaard, Henry, Ph.D., Visiting Professor

DIVISION OF BIOLOGICAL OCEANOGRAPHY

Bayer, Frederick, Ph.D., Professor
Bunt, John, Ph.D., Chairman, Division of Functional Biology and Professor
Cooksey, Keith, Ph.D., Associate Professor
Corcoran, Eugene, Ph.D., Professor
de Sylva, Donald, Ph.D., Associate Professor
Fell, Jack, Ph.D., Assistant Professor
Lane, Charles, Ph.D., Professor
Moore, Hilary, Ph.D., Professor
Myrberg, Arthur, Ph.D., Associate Professor
Owre, Harding, Ph.D., Professor
Reeve, Michael, Ph.D., Assistant Professor
Robins, C. Richard, Ph.D., Professor
Stevenson, Robert, Ph.D., Assistant Professor
Taylor, Barry, Ph.D., Assistant Professor
Taylor, Dennis, Ph.D., Assistant Professor
Thomas, Lowell, Ph.D., Associate Professor
Voss, Gilbert, Ph.D., Chairman, Division of Biological Oceanography and Professor

DIVISION OF MARINE GEOLOGY AND GEOPHYSICS

Ball, Mahlon, Ph.D., Professor
Bock, Wayne, Ph.D., Assistant Professor
Bonatti, Enrico, Ph.D., Associate Professor
Bostrom, Kurt, Ph.D., Associate Professor
Emiliani, Cesare, Ph.D., Chairman and Professor
Fisher, David, Ph.D., Professor
Gartner, Stefan, Ph.D., Assistant Professor
Ginsburg, Robert, Ph.D., Professor
Harrison, Christopher, Ph.D., Associate Professor
Hay, William, Ph.D., Professor
Honnorez, Jose, Ph.D., Research Scientist
Hurley, Robert, Ph.D., Professor
Joensuu, Oiva, Ph.D., Assistant Professor
Marszalik, Donald, Ph.D., Research Scientist
Moore, Donald, Assistant Professor
Neumann, A. Conrad, Ph.D., Associate Professor
Prospero, Joseph, Ph.D., Associate Professor

DIVISION OF CHEMICAL OCEANOGRAPHY

Cratin, Paul, Ph.D., Associate Professor
Gerchakov, Shlomo, Ph.D., Assistant Professor
Millero, Frank, Ph.D., Associate Professor
Ostlund, Hans Gote, Ph.D., Chairman and Professor
Segar, Douglas, Ph.D., Assistant Professor

DIVISION OF PHYSICAL OCEANOGRAPHY

Broida, Saul, Ph.D., Assistant Professor
Duing, Walter, Ph.D., Chairman and Associate Professor
Meincke, Jens, Ph.D., Assistant Professor
Mooers, Christopher, Ph.D., Assistant Professor
Rooth, Claes, Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dr. Robert J. Hurley
Associate Dean for Graduate Studies
School of Marine and Atmospheric Science
University of Miami
10 Rickenbacker Causeway
Miami, Florida 33149

## MICHIGAN STATE UNIVERSITY
### EAST LANSING, MICHIGAN

The University Departments of Physics, Chemistry, Biology, and Geology offer all of the basic courses in those sciences. They are all well-equipped for research purposes. The Department of Geology has access to a microprobe and an electron scanning microscope. A Ph.D. is offered in Geology, but a specialized degree in Oceanography is not offered.

The following courses are offered in conjunction with the above program:

GRADUATE

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 474 | Geophysical Methods | 4 |
| 475 | Geophysics | 3 |
| 476 | Geophysical Laboratory | 3 |
| 477 | Geophysical Studies | 3 |
| 485 | Oceanography | 3 |
| 486 | Oceanography | 3 |
| 495 | Geochemistry | 3 |
| 496 | Geochemistry | 3 |
| 811 | Physical Oceanography | 3 |
| 871 | Advanced Geophysical | |

| | | |
|---|---|---|
| | Laboratory | 3 |
| 872 | Field Seismology | 4 |
| 873 | Fundamentals of Seismology | 3 |
| 874 | Fundamentals of Seismology | 3 |
| 875 | Magnetic Exploration | 4 |
| 876 | Gravity Exploration | 4 |
| 894 | Geochemistry | 3 |
| 899 | Research | |
| 999 | Research | |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOLOGY

Bennett, Hugh F., Ph.D., Assistant Professor of Geology and Geophysics
Hinze, William J., Ph.D., Professor of Geology and Geophysics
Scott, Harold W., Ph.D., Chairman and Professor of Geology
Spooner, Charles, Ph.D., Assistant Professor of Geology and Geochemistry
Upchurch, Sam, Ph.D., Assistant Professor of Geology and Oceanography

To obtain further information, address all inquiries directly to:

Dr. Harold W. Scott
206 Natural Science Building
Michigan State University
East Lansing, Michigan 48823

## THE UNIVERSITY OF MICHIGAN
### ANN ARBOR, MICHIGAN

The department of Meteorology and Oceanography at the University of Michigan includes laboratories for atmospheric turbulence and scintillation research and studies of cloud and precipitation physics, meteorological instrumentation, and facilities for general physical and chemical oceanography and submarine geology.

A fleet of two fully equipped research vessels maintained in the Great Lakes by the Great Lakes Research Division of the University's Institute of Science and Technology are available for staff and student field studies in oceanography. Though the Great Lakes Research Division is a research facility not directly involved in teaching, it has a firm policy of assisting in the educational program through the research of faculty and students.

Many of the oceanography staff of the department of Meteorology and Oceanography are participants in the University's Institutional Sea Grant Program. Sea Grant activities, currently centered on a region of Lake Michigan, involve field studies of sediment chemistry, basin morphology, shallow and deep currents, and local meteorology, complimented with mathematical simulation studies of these same phenomena.

Other recent research activities of faculty and students in oceanography include: air-sea interaction phenomena, circulation and diffusion processes, sediments and sedimentation processes, air-mass modification, water quality modification by man's wastes, geological structure of the Great Lakes basins, Great Lakes climatology, ecology of plankton, and benthic organisms, as well as waves and wave prediction.

The following degrees are offered by the Department of Meteorology and Oceanography:

1. Ph.D. in Oceanography. An applicant for the degree Doctor of Philosophy in Oceanography is expected to have ability and scholarship of a high order in the fundamentals of the science. In oceanography the fundamentals include the following: macro- and micrometeorology, aquatic ecology, sedimentation and stratigraphy, statics and kinematics, geophysics and geochemistry. An applicant will elect such courses as will, in the opinion of the Graduate Guidance Committee for Oceanography, supplement his background and provide him with the techniques needed to carry out independent investigations.

The student may be required to demonstrate his capability in the fundamentals to the Graduate Guidance Committee by passing one or more qualifying examinations before being recommended as an applicant for the doctorate. Approximately half of the student's course work should be in oceanography, with at least two additional courses, for a minimum of six credit hours in mathematics, physical science, or engineering science.

An applicant may become a candidate for the doctorate upon completion of the course requirements, the preliminary examinations, and the general requirements of the Graduate School, including examinations in one foreign language or six hours of graduate credit in the humanities or social sciences approved by the student's adviser.

A dissertation fulfilling the requirements of the Horace H. Rackham School of Graduate Studies will be required of each candidate. The subject for the dissertation may be selected from any of the several areas in oceanography. A satisfactory oral examination of the candidate on the dissertation and related material, conducted by the doctoral committee, completes the requirements for the degree.

2. M.S. in Oceanography. An applicant for the degree of Master of Science in Oceanography is expected to hold a bachelor's degree and to have completed the requirements in mathematics and physics for the Bachelor of Science in Engineering degree (Mathematics 316 and Physics 146 or their equivalent). The bachelor's degree may be one in any field of specialization

Requirements for the degree include 30 hours of graduate studies, approved by one of the graduate advisers, consisting of a minimum of at least 15 credit hours of course work in oceanography, and a minimum of six credit hours of mathematics or three credit hours of mathematics and three credit hours of physical science or engineering science. Six credit hours of course work in oceanography may, after agreement with the graduate adviser, be replaced by a master's thesis.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE

| | |
|---|---|
| 304 | Introduction to Atmospheric and Oceanic Sciences I |
| 305 | Introduction to Atmospheric and Oceanic Sciences II |
| 306 | Laboratory in Geophysical Data I |
| 307 | Laboratory in Geophysical Data II |
| 333 | Physical Oceanography |
| 350 | Ocean Engineering I |
| 351 | Geophysical Fluid Dynamics |
| 360 | Oceanographic Field Methods |

GRADUATE

| | |
|---|---|
| 417 | Geology of the Great Lakes |
| 442 | Ocean Dynamics I |
| 449 | Marine Geology |
| 450 | Ocean Engineering II |
| 478 | Marine Chemistry |
| 526 | Dynamics of the Oceans and Atmosphere |
| 531 | Marine Ecology |
| 542 | Oceanic Dynamics II |
| 550 | Ocean Engineering III |
| 560 | Oceanography Field Practicum |
| 579 | Atmospheric and Marine Radioactivity |
| 605 | Current Topics in Meteorology and Oceanography |
| 701 | Special Problems in Meteorology and Oceanography |
| 991 | Oceanographic Research |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF METEOROLOGY AND OCEANOGRAPHY

Ayers, John C., Ph.D., Professor of Oceanography
Baker, Dennis G., Ph.D., Assistant Professor of Meteorology
Bartman, Frederick L., Ph.D., Associate Professor of Meteorology and Aerospace Engineering
Callender, Edward, Ph.D., Assistant Professor of Oceanography
Dingle, A.N., Sc.D., Professor of Meteorology
Drayson, S. Roland, Ph.D., Assistant Professor of Meteorology
Epstein, Edward S., Ph.D., Professor of Meteorology
Gill, Gerald C., M.A., Professor of Meteorology
Green, Albert W., Jr., Ph.D., Assistant Professor of Oceanography
Hough, J.L., Ph.D., Professor of Oceanography
Jacobs, S.J., Ph.D., Associate Professor of Oceanography
Kuhn, William R., Ph.D., Assistant Professor of Meteorology
Monahan, Edward C., Ph.D., Assistant Professor of Oceanography
Portman, Donald J., Ph.D., Professor of Meteorology
Washington, W.M., Ph.D., Adjunct Associate Professor of Meteorology
Wiin-Nielsen, Aksel C., Ph.D., Chairman and Professor of Meteorology

To obtain further information, address all inquiries directly to:

Dr. A. Wiin-Nielsen, Chairman
Department of Meteorology and Oceanography
4072 East Engineering Building
The University of Michigan
Ann Arbor, Michigan 48104

## NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

The Department of Oceanography, established in 1968, offers graduate education in oceanography for active duty military officers. The Department operates a 63-foot hydrographic research vessel, and, for two weeks each quarter, a ship from the Pacific AGOR pool. Laboratory facilities are modest at present, but include a small sediments laboratory, a biological laboratory, as well as chemical and geological laboratories. Also utilized are facilities in the Departments of Electrical Engineering, Physics, Mechanical Engineering, and Material Science and Chemistry.

The degree of Master of Science in Oceanography (with two options) is offered. Departmental Requirements: Entrance to a program leading to the degree of Master of Science in Oceanography requires a baccalaureate degree in a field appropriate to the oceanography option chosen. Minimal requirements include mathematics through differential and integral calculus, one year of college physics, and one year of college chemistry. The degree of Master of Science in Oceanography requires:

a. Completion of 35 quarter hours of graduate courses of which 15 hours must be in the 4000 Oceanography series. The entire sequence of courses for the particular option selected must be approved by the Department of Oceanography.

b. An acceptable thesis on a topic approved by the Department of Oceanography.

Objectives of the Options in Oceanography:

Physical - To provide a broad basic education in oceanography, including courses in biological, geological, and chemical oceanography. The core element is physical oceanography. Emphasis is placed upon the application of oceanography to naval operations, and practical experience with instruments and observations.

Operations - To provide the broad spectrum of fundamental principles and information included in the ocean sciences. To improve the capability of solving problems associated with surface and underwater warfare including those involving weapons, search, rescue, recovery, salvage, oceanographic data collection, and the support of emplacements and facilities.

The degree of Master of Science in Engineering Acoustics is offered as an interdisciplinary program in Engineering Acoustics with courses drawn principally from the fields of electrical engineering and physics. The emphasis is on those aspects of acoustics concerning propagation of sound in water, in applications of underwater sound, and on the electrical engineering of instrumentation for underwater sound detection.

Degree Requirements are:

a. A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.

b. The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter hours of course work; at least 20 graduate quarter hours must be taken in acoustics and its applications. One 4000 level course from each of the three following areas must be included: wave propagation, vibration and noise control, transducer theory, sonar systems, and signal processing.

c. An acceptable thesis must be completed.

The following courses are offered in conjunction with the above programs. Credits are in quarter hours.

DEPARTMENT OF OCEANOGRAPHY

UPPER DIVISION COURSES

| | | |
|---|---|---|
| OC 2110 | Introduction to Oceanography | 3 |

UPPER DIVISION OR GRADUATE COURSES

| | | |
|---|---|---|
| OC 3150 | Geophysical Random Processes | 5 |
| OC 3221 | Descriptive Oceanography | 4 |
| OC 3250 | Dynamical Oceanography | 4 |
| OC 3260 | Sound in the Ocean | 3 |
| OC 3320 | Geological Oceanography | 4.5 |
| OC 3420 | Biological Oceanography | 4.5 |
| OC 3520 | Chemical Oceanography | 4 |
| OC 3601 | Ocean Wave Forecasting | 3 |
| OC 3605 | Ocean Wave Forecasting Laboratory | 3 |
| OC 3611 | Ocean Wave and Surf Forecasting | 2 |
| OC 3615 | Ocean Wave and Surf Forecasting Laboratory | 3 |
| OC 3616 | Oceanographic Forecasting | 3 |
| OC 3621 | Oceanographic Forecasting Laboratory | 2 |
| OC 3700 | Oceanographic Instrumentation and Observations | 3 |
| OC 3710 | Field Experience in Oceanography | 2 |
| OC 3801 | Ocean Operations I | 3.5 |

GRADUATE COURSES

| | | |
|---|---|---|
| OC 4211 | Waves and Tides | 4 |
| OC 4213 | Coastal Oceanography | 4.5 |
| OC 4251 | Dynamical Oceanography I | 4 |
| OC 4252 | Dynamical Oceanography II | 4 |
| OC 4253 | Dynamical Oceanography III | 3 |
| OC 4260 | Sound in the Ocean | 3 |
| OC 4340 | Marine Geophysics | 3 |
| OC 4421 | Marine Ecology | 3 |
| OC 4422 | Marine Fouling | 1.5 |
| OC 4612 | Polar Oceanography | 3 |
| OC 4800 | Special Topics in Oceanography | 3 |
| OC 4802 | Ocean Operations II | 3.5 |
| OC 4803 | Physical Properties of Marine Sediments | 3.5 |
| OC 4851 | Geophysics: Earth Gravity | 4 |
| OC 4852 | Geophysics: Earth Magnetism and Electricity | 4 |
| OC 4853 | Geophysics: Sound and Seismicity | 4 |
| OC 4860 | Physics of the Earth | 3 |
| OC 4900 | Seminar in Oceanography | 3 |
| OC 4901 | Seminar in Ocean Operations | 3 |

DEPARTMENT OF ELECTRICAL ENGINEERING

| | | |
|---|---|---|
| EE 2114 | Communication Theory I | 4 |
| EE 3116 | Communication Theory II | 4 |
| EE 3311 | Energy Conversion | 4 |
| EE 3622 | Electromagnetic Theory | 3 |
| EE 3731 | Instruments and Equipment for Ocean Operation | 5.5 |
| EE 4451 | Sonar Systems Engineering | 4 |
| EE 4452 | Underwater Acoustic System Engineering | 5 |
| EE 4541 | Signal Processing | 3.5 |
| EE 4571 | Statistical Communications Theory | 4 |
| EE 4581 | Information Theory | 3.5 |

DEPARTMENT OF PHYSICS

| | | |
|---|---|---|
| PH 3157 | Physics of Continua | 4 |
| PH 3431 | Physics of Sound in the Ocean | 5 |
| PH 3451 | Fundamental Acoustics | 4.5 |
| PH 3452 | Underwater Acoustics | 5 |
| PH 3463 | Special Topics in Underwater Acoustics | 4 |
| PH 4453 | Propagation of Waves in Fluids | 4 |
| PH 4454 | Transducer Theory and Design | 4 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF OCEANOGRAPHY

Andrews, Robert S., Ph.D., Assistant Professor of Oceanography
Boston, Noel E.J., M.S., Assistant Professor of Oceanography
Denner, Warren W., Ph.D., Associate Professor of Oceanography
Galt, Jerry A., Ph.D., Assistant Professor of Oceanography
Haderlie, Eugene C., Ph.S., Professor of Oceanography
Jung, Glenn H., Ph.D., Professor of Oceanography
Knodle, William C., LCDR, U.S. Navy, Instructor
Leipper, Dale F., Ph.D., Chairman and Professor of Oceanography
Smith, Raymond J., Ph.D., Professor of Oceanography
Thompson, Warren C., Ph.D., Professor of Oceanography
Thornton, Edward B., Ph.D., Assistant Professor of Oceanography
Traganza, Eugene D., Ph.D., Associate Professor of Oceanography
Von Schwind, Joseph J., Ph.D., Associate Professor of Oceanography
Wickham, Jacob B., M.S., Associate Professor of Oceanography

The Engineering Acoustics program is under the direction of the following committee:

Lockhart, Brooks J., Ph.D., Chairman and Dean of Curricula
Medwin, Herman, Ph.D., Professor of Physics
Sackman, George L., Ph.D., Associate Professor of Electrical Engineering

Other professors closely connected to the program include:

Meyers, Glen A., Ph.D., Associate Professor of Electrical Engineering
Stentz, Donald A., M.S., Associate Professor of Electrical Engineering
Coppens, Alan B., Ph.D., Assistant Professor of Physics
Eller, Anthony I., Ph.D., Assistant Professor of Physics
Sanders, James U., Ph.D., Associate Professor of Physics
Wilson, O. Bryan, Ph.D., Professor of Physics

To obtain further information, address all inquiries directly to:

Dr. Dale F. Leipper, Chairman
Department of Oceanography
Naval Postgraduate School, Code 58
Monterey, California 93940

Dr. Brooks J. Lockhart
Dean of Curricula
Naval Postgraduate School, Code 022
Monterey, California 93940

## UNIVERSITY OF NEW HAMPSHIRE
### DURHAM, NEW HAMPSHIRE

The University of New Hampshire has unique natural facilities for marine studies. The 15,000 acre Great Bay estuarine system is adjacent to the campus. The coastline of the open Atlantic is less than fifteen miles away with the Isles of Shoals a few miles off shore. Because of this situation the University has had a history of substantial academic programs in the fields of marine science and ocean engineering.

The recently constructed Jackson Estuarine Laboratory at Adams Point on Great Bay is primarily a facility for the marine-oriented faculty members of the departments of Biochemistry, Botany, Geology, Microbiology, and Zoology. Cooperation is extended to ocean engineers who are providing instrumentation to collect physical oceanographic data from the estuary. In addition to research facilities, the 8,400 square-foot laboratory includes a seawater system and a dock to accommodate the University oceanographic vessel, the 45-foot R/V JERE A. CHASE. Research in the marine food-web, marine biotoxins, chemical and biological pollution, as well as physical and geological oceanography, is conducted in the estuary and out into the waters above the continental shelf.

The departments of Biochemistry, Botany, Microbiology, Zoology, and Geology, which are all involved in marine research, have facilities on the Durham campus. Equipment includes a running seawater system in Zoology an electron microscope in Microbiology, and a Beckman automatic amino acid analyzer in Biochemistry. The departments of Physics and Chemistry offer background courses and facilities or equipment such as an underwater sound laboratory in Physics and a mass spectrometer in Chemistry.

Oceanography at the University of New Hampshire is multidisciplinary. Students wishing to prepare themselves for careers in oceanography or marine science enroll as a major in an existing department. The ocean-oriented content of the program is arranged in consultation with the academic advisors in the various departments. The student will find ample opportunity to participate in the broad spectrum of marine research in the life sciences, physical sciences, or engineering, all in progress at the University.

The following degrees are offered:

1. Department of Biochemistry: B.S., M.S., Ph.D.
2. Department of Botany: M.S. B.S., Ph.D.
3. Department of Geology: B.A., M.S.
4. Department of Microbiology: B.A., M.S., Ph.D.
5. Department of Zoology: B.A., M.S., Ph.D.

The following courses are offered in conjunction with the above programs:

BIOLOGY

| | | |
|---|---|---|
| 641 | Principles of Ecology | 4 |

BOTANY

| | | |
|---|---|---|
| 723 | Introduction of Biological Oceanography and Marine Ecology | 4 |
| 722 | Marine Phycology | 4 |
| 822 | Advanced Marine Phycology | 4 |

MICROBIOLOGY

| | | |
|---|---|---|
| 707 | Marine Microbiology | 4 |

ZOOLOGY

| | | |
|---|---|---|
| 704 | Comparative Endocrinology | 4 |
| 711 | Natural History of Cold-Blooded Vertebrates | 4 |
| 715 | Natural History of Marine Invertebrates | 4 |
| 803 | Marine Ecology | 4 |
| 820 | Invertebrate Zoology | 4 |
| 821 | Invertebrate Zoology | 4 |
| 822 | Protozoology | 4 |
| 823 | The Host-Parasite Relationship | 4 |
| 826 | Comparative Physiology | 4 |
| 830 | Invertebrate Embryology | 4 |

GEOLOGY

| | | |
|---|---|---|
| 501 | Introduction to Oceanography | 4 |
| 816 | Mineralogy of Clays | 3 |
| 741 | Geochemistry | 4 |
| 754 | Sedimentology | 4 |
| 759 | Geological Oceanography | 4 |
| 856 | Estuarine and Marine Sedimentation | 3 |

An introductory course in marine science is given in June in cooperation with Cornell University. Two weeks are spent at the Isles of Shoals followed by two weeks on the University of New Hampshire campus.

The University also offers undergraduate and graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

LIFE SCIENCE

Borror, Arthur C., Ph.D., Associate Professor of Zoology
Bullock, Wilbur L., Ph.D., Professor of Zoology
Chesbro, William R., Ph.D., Professor of Microbiology
Croker, Robert A., Ph.D., Assistant Professor of Zoology
Green, D. MacDonald, Ph.D., Professor of Biochemistry
Hagstrom, Earl C., Ph.D., Associate Professor of Psychology
Harris, Larry G., M.S., Instructor of Zoology
Herbst, Edward J., Ph.D., Chairman and Professor of Biochemistry
Ikawa, Miyoshi, Ph.D., Professor of Biochemistry
Jones, Galen E., Ph.D., Director of Jackson Estuarine Laboratory and Professor of Microbiology
Klippenstein, Gerald L., Ph.D., Assistant Professor of Biochemistry
Mathieson, Arthur C., Ph.D., Associate Professor of Botany
Metcalf, Theodore G., Ph.D., Professor of Microbiology
Milne, Lorus J., Ph.D., Professor of Zoology
Sasner, John J., Ph.D., Associate Professor of Zoology
Sawyer, Philip J., Ph.D., Professor of Zoology

Slanetz, Lawrence W., Ph.D., Director of Health Studies and Professor of Microbiology
Swan, Emery F., Ph.D., Professor of Zoology
Tillinghast, Edward, Ph.D., Assistant Professor of Zoology
Wood, Langley, Ph.D., Chairman, and Professor of Zoology

PHYSICAL SCIENCE

Anderson, Franz E., Ph.D., Assistant Professor of Geology
Clark, David G., Ph.D., Associate Professor of Physics
Gaudette, Henri E., Ph.D., Associate Professor of Geology
Hall, Harry H., Ph.D., Professor of Physics
Tischler, Herbert, Ph.D., Chairman and Professor of Geology
Wiseman, William J., Jr., Ph.D., Assistant Professor of Geology

To obtain further information, address all inquiries directly to:

Office of Marine Science and Technology
Kingsbury Hall
University of New Hampshire
Durham, New Hampshire 03824

## CITY UNIVERSITY OF NEW YORK
### NEW YORK, NEW YORK

The University consists of nine senior and eight junior colleges. Classwork and research space are offered at some of the individual campuses. Through joint appointments, additional research space is available at the Lamont-Doherty Geological Observatory. Students and staff will have access to our 90-foot vessels specially equipped for estuarine and nearshore studies. More extensive oceanic work is possible through CONRAD and VEMA (Lamont-Doherty Geological Observatory) and EASTWARD (National Science Foundation and Duke University). Special arrangements can also be implemented at a variety of local and sub-tropical research institutions. Facilities of the City University also include a mobile field laboratory; working skiff; small launch; combined library holdings of nearly two million books and 8,000 periodicals; and assorted computers (an IBM 7040, four IBM 1620's, an IBM 360-50, and a Sigma-70). (All marine facilities are available to other institutions in the New York, New Jersey and Connecticut area.)

The University offers the following degrees in marine science fields through the departments indicated:

1. B.S. in Oceanography, Interdisciplinary Group in Oceanography. This degree is available only at the City College. Students are required to complete 128 credits with an average of "C" or better. In meeting this standard, students: (a) must take a minimum of 44 credits outside their major subject and a minimum of 36 credits in their major, (b) are unlimited in what they take to meet a maximum of 48 credits as free electives, (c) may take up to 16 credits of non-major study on a pass-fail basis, and (d) must select an approved program of study in an oceanographic discipline.

2. M.A. in Biology, Chemistry, Geology, and Physics, Departments of Biology, Chemistry, Geology, and Physics. Generally speaking, the student must: (a) complete 30 credits in an approved program of study with an average grade of "B" or better, (b) demonstrate a reading knowledge of one foreign language and (c) present an original monograph or additional laboratory research credits. Students in Biology and Chemistry must pass a comprehensive examination.

3. Ph.D. in Biology, Chemistry, Geology, and Physics, University Committees in Biology, Chemistry, Geology, and Physics. Generally 60 credits are required including a specific array of courses: Advanced Inorganic Chemistry, Advanced Organic Chemistry, Quantum Chemistry, Chemical Thermodynamics and Basic Laboratory Techniques for Research. All Students are required to complete an approved program of study and to pass a First Examination (comprehensive) and a Second Examination (special field). A dissertation is required in all programs. Chemistry requires the student to demonstrate a reading knowledge of two foreign languages; in Biology, computer programming may be substituted for a second foreign language. These same two University Committees require that their students display competence in college teaching.

Undergraduate courses are offered to qualified residents of New York State on a nominal or free basis. Graduate programs are open to qualified applicants whether residents of New York State or not. Marine Geology is centered at Queens College; Marine Biology at the City College. Students are not limited to taking courses at their own campus. Some graduate and undergraduate marine courses are offered in the summer, but realistically a student should presume courses leading to a degree only during the regular year. Oceanographic training at all levels is accomplished through special course work added to the usual science and engineering departments.

The following courses are offered in conjunction with the above programs:

BIOLOGY

| | | |
|---|---|---|
| 111 | Biology of Vertebrates | 4 |
| 112 | Biology of Invertebrates | 4 |
| 216 | Principles of Ecology | 2 |
| 221 | Lower Plants | 4 |
| 274 | Biological Oceanography | 4 |
| 293 | Senior Seminar | 2 |
| 298 | Independent Study-Honors | 4 |
| 762 | Physiological Ecology | 3 |
| 762.1 | Physiological Ecology | 3 |
| 761.1 | Marine Plankton Dynamics | 3 |
| 761.2 | Marine Plankton Dynamics | 3 |
| 761.3 | Marine Benthos | 3 |
| 761.4 | Marine Benthos | 3 |
| 761.5 | Fishes and Fisheries Biology | 3 |
| 761.6 | Fishes and Fisheries Biology | 3 |
| 761.7 | Marine Microbiology | 3 |
| 761.8 | Marine Microbiology | 3 |
| 761.9 | Marine Ecology | 4 |
| 780 | Mathematical Biology | 3 |
| 790.63 | Seminar In Biological Oceanography | 3 |
| 790.64 | Seminar in Behavioral Ecology | 3 |
| 791 | Colloquium | 1 |
| 792 | Tutorial | 4 |
| 899 | Independent Doctoral Research | Max. 10 |

CHEMISTRY

| | | |
|---|---|---|
| 12 | Inorganic Chemistry | 4 |
| 30 | Physical Chemistry I | 3 |
| 31 | Physical Chemistry Laboratory I | 2 |
| 32 | Physical Chemistry II | 3 |
| 33 | Physical Chemistry Laboratory II | 2 |
| 46 | Chemical Instrumentation | 4 |
| 55 | Organic Chemistry I | 5 |
| 56 | Organic Chemistry II | 5 |
| 59 | Biochemistry | 4 |
| 99.301-304 | Independent Study Honors | 4-16 |
| 710 | Advanced Inorganic Chemistry | 3 |
| 750 | Advanced Organic Chemistry I | 3 |
| 751 | Advanced Organic Chemistry II | 3 |
| 760 | Introductory Quantum Chemistry | 3 |
| 810.1-.4 | Doctoral Research | Var. |

GEOLOGY

| | | |
|---|---|---|
| 27 | Structural Geology I | 4 |
| 28 | Structural Geology II | 4 |
| 21 | Invertebrate Paleontology | 4 |
| 25 | Sedimentation and Sedimentary Petrography | 2 |
| 30 | Stratigraphy I | 4 |
| 31 | Stratigraphy II | 4 |
| 45 | Hydrology | 4 |
| 61 | Introduction to Geophysics | 4 |
| 64 | Physical Oceanography | 4 |
| 65 | Marine Geology | 4 |
| 70 | Field Geology | |
| 71 | Field Geology | |
| 1714 | Advanced Geophysics | 3 |
| 1732 | Paleoecology | 3 |
| 1740 | Advanced Sedimentology | 3 |
| 1743 | Advanced Sediment | 3 |

METEOROLOGY

| | | |
|---|---|---|
| 17 | General Meteorology | 4 |
| 18 | Climatology | 4 |
| 42 | Synoptic Meteorology I | 4 |
| 43 | Synoptic Meteorology II | 4 |
| 51 | Statistical Methods | 4 |
| 53 | Weather Forecasting | 4 |
| P53 | Thermodynamics for Geologists and Meteorologists | 3 |
| P55 | Physical Meteorology | 3 |
| P56 | Dynamic Meteorology | 3 |
| P57 | Physics of the Upper Atmosphere | 3 |

PHYSICS

| | | |
|---|---|---|
| 9 | Mechanics | 4 |
| 10 | Mechanics | 4 |
| 13 | Thermodynamics | 4 |
| 55 | Physical Meteorology | 4 |
| 56 | Dynamic Meteorology | 4 |

The instructional staff for the courses listed above consists of the following:

UNIVERSITY COMMITTEE IN OCEANOGRAPHY

Donn, William L., Ph.D., Professor of Geology, The City College
Lee, John J., Ph.D., Associate Professor of Biology, The City College
McIntyre, Andrew, Ph.D., Assistant Professor of Geology, Queens College
Posner, Gerald S., Ph.D., Executive Officer for Oceanography and Associate Professor of Biology, The City College
Thurber, David, Ph.D., Professor of Geology, Queens College
Tietjen, John H., Ph.D., Assistant Professor of Biology, The City College

BIOLOGY

Bé Allan, Ph.D., Associate Professor of Biology, The City College
Goldstein, Solomon, Ph.D., Associate Professor of Biology, Brooklyn College
Hecht, Max, Ph.D., Professor of Biology, Queens College
Koulish, Sasha, Ph.D., Assistant Professor of Biology, Richmond College
Pierce, Stanley, Ph.D., Associate Professor of Biology, Queens College
Rachlin, Joseph, Ph.D., Assistant Professor of Biology, Lehman College
Roels, Oswald, Ph.D., Professor of Biology, The City College
Sacks, Martin, Ph.D., Professor of Biology, The City College
Shields, Robert W., Ph.D., Associate Professor of Biology, The City College
Smith, C. L., Adjunct Associate Professor of Biology, The City College
Tavolga, William N., Ph.D., Professor of Biology, The City College

CHEMISTRY

Barrett, Edward, Ph.D., Assistant Professor of Chemistry, Hunter College
Blei, Ira C., Ph.D., Assistant Professor of Chemistry, Richmond College
Haines, Thomas H., Ph.D., Associate Professor of Chemistry
Soloway, Saul, Ph.D., Associate Professor of Chemistry
Wiley, Richard H., Ph.D., Professor of Chemistry, Hunter College

GEOLOGY

Burckle, Lloyd, M.S., Lecturer in Geology, Hunter College
Coch, Nicholas, Ph.D., Associate Professor of Geology, Queens College
Fagan, Joh, Ph.D., Assistant Professor of Geology
Feeley, Herbert, Ph.D., Associate Professor of Geology, Queens College
Franke, Lehn, Ph.D., Assistant Professor of Geology, The City College
Habib, Daniel, Ph.D., Associate Professor of Geology, Queens College
Herron, Thomas, Ph.D., Associate Professor of Geology, The City College
Krinsley, David, Ph.D., Professor of Geology, Queens College
Loring, Arthur, Ph.D., Assistant Professor of Geology, York College
Mencher, Ely, Ph.D., Professor of Geology
Newman, Walter S., Ph.D., Assistant Professor of Geology, Queens College
Schaffel, Simon, M.S., Lecturer in Geology
Schreiber, Edward, Ph.D., Associate Professor of Geology, Queens College

METEOROLOGY

Ehrlich, Albert, Ph.D., Associate Professor of Geology, The City College
Gedzelman, Stanley, Ph.D., Assistant Professor of Geology, The City College
Rommer, Richard, M.S., Lecturer in Geology, The City College
Stolov, Harold, Ph.D., Associate Professor of Physics, The City College

PHYSICS

Brown, M. Vertner, Ph.D., Professor

of Physics
Guthrie, Albert, Ph.D., Professor of Physics, Brooklyn College
Thorndike, Edward, Ph.D., Professor of Physics, Queens College

To obtain further information, address all inquiries directly to:

Dr. Gerald S. Posner
Executive Officer for Oceanography
The City College
Convent Avenue and 138th Street
New York, New York 10031

## STATE UNIVERSITY OF NEW YORK AT STONY BROOK
### STONY BROOK, NEW YORK

On campus marine science laboratories are housed in a new lab-office building (March 1971) with 14 research and teaching laboratories and others in an adjacent Biological Sciences building. Flax Pond, a 160-acre salt water marsh four miles north of the campus, is maintained as a teaching and instructional preserve by the State University of New York and the State Environmental Conservation Department. The Discovery Bay Marine Biology Laboratory, Jamaica, West Indies, was completed in 1970 and is jointly operated by the University of the West Indies and the State University of New York. State University, through the Marine Sciences Research Center at Stony Brook, is participating with Cornell in the development of the marine station on the Isles of Shoals off the coast of New Hampshire. The Marine Sciences Research Center operates the 40-foot R/V MICMAC and a number of smaller boats for work in local waters.

Degree programs in the marine sciences are offered at the graduate level on the Stony Brook campus of the State University of New York. These include a terminal M.S. program in Marine Environmental Studies aimed at preparing professionals in the field of marine environmental management and an M.A./Ph.D. porgram in Marine Biology.*

1. M.S. in Marine Environmental Studies (Joint Faculties of the Marine Sciences Research Center and the Marine Environmental Studies Program). The program is designed to prepare students to collaborate in many disciplines toward the solution of marine environmental problems. Formal instruction consists of a thoroughly interdisciplinary, problem-oriented curriculum offered by a closely interacting faculty representing many fields. To open the program to practicing professionals, the University residence requirement has been waived and students may also enroll on a part-time basis. All students must complete an approved course of study, normally 30 credits or more and including courses MAR 501, 502, 513, 521, 522, and 580. As a requirement for the degree, students are expected to participate in a research program and submit a research paper dealing with a problem of the marine environment.

2. M.A./Ph.D. in Marine Biology (Jointly sponsored by the Biological Sciences Division and the Marine Sciences Research Center - Marine Environmental Studies Program). Requirements for the Ph.D. degree in Marine Biology are: (1) two years in residence as a full-time graduate student; (2) completion of an approved course of study, normally four semesters of course work; (3) a reading knowledge of one foreign language; (4) competence in computer languages and programming; (5) successfully sustain the Preliminary Examination, normally following completion of a major portion of the course work; (6) submission of an acceptable dissertation and an oral examination on the dissertation research and related areas.

Requirements for the Master's degree in Marine Biology include one year of residence and requirements one through four of the doctoral program. A student may be permitted to substitute the submission and defense of a Master's dissertation for requirement four.

*An M.A./Ph.D. program in Marine Geology is being planned for September 1971.

The following courses are offered in conjunction with the above programs:

GRADUATE COURSES

MARINE ENVIRONMENTAL STUDIES PROGRAM

| | |
|---|---|
| MAR 501 | The Marine Environment (Physical) |
| MAR 502 | The Marine Environment (Biological) |
| MAR 503 | Problems in Marine Resource Management |
| MAR 511 | Marine Instrumentation |
| MAR 512 | Field Studies |
| MAR 513 | Scientific Reporting and Communication |
| MAR 514 | Socio-economic Aspects of the Coastal Zone |
| MAR 521 | General Problems of the Marine Environment |
| MAR 522 | Case Studies |
| MAR 550 | Topics in Marine Sciences |
| MAR 551 | Topics in Physical Oceanography |
| MAR 552 | Topics in Marine Legal-Political Arragements |
| MAR 553 | Topics in Fisheries Ecology |
| MAR 580 | Seminar |
| MAR 590 | Research |

MARINE BIOLOGY

REQUIRED COURSES

| | |
|---|---|
| BIO 553 | Biometry |
| MAR 501 | The Marine Environment (Physical) |
| MAR 502 | The Marine Environment (Biological) |
| MAR 551 | Topics in Physical Oceanography |
| MAR 511 | Marine Instrumentation |
| ESG 162 | Computer Science |

ELECTIVES (students ordinarily take two or more)

| | |
|---|---|
| BIO 334 | Marine Vertebrate Zoology |
| BIO 338 | Marine Planktonology |
| BIO 321 | Microbiology |
| BIO 384 | Biological Clocks |
| BIO 536 | Physiology and Development of Lower Plants |

OTHER COURSES SUITABLE FOR MARINE BIOLOGY

| | |
|---|---|
| BIO 501 | Biochemistry |
| BIO 503 | Mechanisms of Enzyme Action |
| BIO 505 | Microbial Regulatory Mechanisms |
| BIO 507 | Chemistry and Enzymology of Nucleic Acids |
| BIO 509 | Experimental Biochemistry I |
| BIO 510 | Experimental Biochemistry II |
| BIO 512 | Cellular Biology |
| BIO 513 | Graduate Seminar in Molecular and Cellular Biology |

BIO 514 Graduate Seminar in Molecular and Cellular Biology
BIO 515 Molecular and Cellular Biology Workshop
BIO 516 Molecular and Cellular Biology Workshop
BIO 520 Molecular Biology of Viruses
BIO 523 Topics in Animal Development
BIO 524 Cellular Aspects of Development
BIO 530 Projects in Developmental Biology
BIO 531 Graduate Seminar in Development Biology
BIO 532 Graduate Seminar in Development Biology
BIO 543 Topics in Animal Behavior and Physiology
BIO 544 Laboratory in Neurophysiology
BIO 550 Practicum in Ecology
BIO 551 Principles of Ecology
BIO 552 Multivariate Analysis in Biology
BIO 554 Population Genetics
BIO 570 Population and Community Ecology
BIO 575 Macromolecular Evolution
BIO 601 Colloquim in Molecular and Cellular Biology
BIO 602 Colloquim in Molecular and Cellular Biology
BIO 621 Developmental Biology Seminar
BIO 622 Developmental Biology Seminar
BIO 671 Seminar in Ecology and Evolution
BIO 672 Seminar in Ecology and Evolution

RELATED COURSES IN OTHER DEPARTMENTS

ESS 363 Sediments and Sedimentary Processes
ESS 364 Marine Geology
ESS 511 Advanced Paleontology
ESS 513 Micropaleontology
ESC 361 Applied Aero- and Hydromechanics

The instructional staff for the courses listed above consists of the following:

MARINE ENVIRONMENTAL STUDIES PROGRAM

Baylor, Edward, Ph.D., Professor of Biological Sciences
Boyce, James R., M. Arch., Research Scientist in Urban and Regional Planning
Caplan, Ronald, Instructor, Biological Sciences
Gross, M. Grant, Ph.D., Professor of Oceanography
Koppelman, Lee E., Ph.D., Adjunct Professor of Political Sciences
McHugh, John L., Ph.D., Professor of Biological Sciences
Miller, H. Crane, LL.B., Visting Professor of Law
Squires, Donald F., Ph.D., Professor of Biological Sciences and Earth and Space Sciences
Terry, Orville, Ph.D., Research Biologist
Weyl, Peter K., Ph.D., Professor of Oceanography
Williams, George C., Ph.D., Professor of Biological Sciences
Wurster, Charles F., Ph.D., Assistant Professor of Environmental Sciences

DEPARTMENT OF BIOLOGY

Battley, Edwin H., Ph.D., Associate Professor of Biological Sciences
Carlson, Albert D., Ph.D., Associate Professor of Biological Sciences
Edmunds, Leland, Ph.D., Associate Professor of Biological Sciences
Gaudet, John T., Ph.D., Assistant Professor of Biological Sciences
Hechtel, George T., Ph.D., Assistant Professor of Biological Sciences
Jones, Raymond F., Ph.D., Professor of Biological Sciences
Lyman, Harvard, Ph.D., Associate Professor of Biological Sciences
Rohlf, F. James, Ph.D., Associate Professor of Biological Sciences
Slobodkin, Lawrence B., Ph.D., Professor of Biological Sciences
Tunik, Bernard D., Ph.D., Associate Professor of Biological Sciences
Walcott, Charles, Ph.D., Associate Professor of Biological Sciences

To obtain further information, address all inquiries directly to:

Dr. Charles F. Wurster
Director of Graduate Studies
Marine Sciences Research Center
State University of New York
Stony Brook, New York 11790

## NEW YORK UNIVERSITY
### NEW YORK, NEW YORK

Courses in meteorology and oceanography are given at the University Heights campus (Bronx). The equipment of the Department includes the research vessel KYMA; a complete meteorological station that is used to train students in weather analysis and forecasting; and laboratories for meteorological optics and physics, atmospheric chemistry, and oceanographic analysis. Students specializing in oceanography and air-sea interactions are encouraged to take part in the research cruises of the KYMA. Weather data collected from the United States and Canada, from ships on the Pacific and Atlantic Oceans, from weather radar and from weather satellites, are available for student analysis and practice weather forecasts.

The following degrees are offered by the Department of Meteorology and Oceanography:

1. B.S. in Meteorology and Oceanography. To prepare for a career in meteorology and/or oceanography a student should have a thorough foundation in mathematics and physics, as well as a broad education in the content and methods of the geophysical sciences generally. The curriculum in the Department of Meteorology and Oceanography includes intensive study in mathematics and physics, providing a sound foundation for advanced study leading to advanced degrees.

2. M.S. in Meteorology or Oceanography. A minimum of 36 credits, of which 24 must be taken in the Department, is required. Also required is a paper, suitable for publication, according to either of two alternative plans, the choice of which is made by the student with the permission of his adviser. Plan A: An acceptable research thesis demonstrating the student's ability to attack and solve a scientific or technical problem. Plan B: An essay consisting of a critical review of the literature in a selected area of meteorology or oceanography.

3. Ph.D. (with major in Meteorology or Oceanography). At least 60 of the 72 required credits must be in meteorology, oceanography, physics, mathematics, or

chemistry, and of these 60 credits at least 42 must be in meteorology and oceanography. Students whose major interest is meteorology are expected to acquire a basic knowledge of physical and dynamical oceanography; students whose major interest is oceanography are expected to acquire a basic knowledge of meteorology. A reading knowledge of any one of the following languages is required: German, French, Japanese, Russian; in certain cases another foreign language may be substituted on petition by the student.

Qualifying examinations in physics and mathematics are taken as early as possible in order to qualify students to take courses beyond the master's level. A student who has spent at least one year in residence, who has either passed a foreign language proficiency test or is registered in a course in an appropriate foreign language, and who has passed the qualifying examinations may apply to the Department chairman for admission to provisional candidacy for the Ph.D. degree. The student is then assigned to a faculty committee with whom he meets regularly for guidance and demonstration of his potentiality as a doctoral candidate. The committee determines after about one academic year whether the student is acceptable as a candidate for the Ph.D. degree.

The doctoral dissertation is a scholarly presentation of the candidate's original research on a problem of importance in meteorology or oceanography. After submission of the dissertation, a final general examination will comprise topics in the field of the dissertation, and the doctoral committee decides if the degree is to be awarded.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF METEOROLOGY AND OCEANOGRAPHY

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| T69.0030 | Introduction to the Geophysical Sciences | 4 |
| T69.0040 | Introduction to the Geophysical Sciences | 4 |
| T69.0050 | Dynamic Meteorology and Oceanography | 3 |
| T69.0060 | Dynamic Meteorology and Oceanography | 3 |
| T69.0051 | Descriptive Meteorology and Oceanography | 3 |
| T69.0061 | Descriptive Meteorology and Oceanography | 3 |
| T69.0052 | Weather Analysis and Forecasting | 4 |
| T69.0062 | Weather Analysis and Forecasting | 4 |
| T69.0070 | Physical Meteorology | 3 |
| T69.0071 | Theoretical Geophysics | 3 |
| T69.0072 | Senior Seminar in Meteorology and Oceanography | 3 |
| T69.0077 | Oceanography | 4 |
| T69.0087 | Oceanography | 4 |
| T69.0080 | Statistical Methods in the Geophysical Sciences | 3 |
| T69.0081 | Dynamical Weather Prediction | 3 |
| T69.0082 | Weather Station Operation | 3 |
| T69.0093 | Senior Thesis | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| T69.1102 | Principles of Meteorological and Oceanographic Instruments | 3 |
| T69.1103 | The Planet Earth | 3 |
| T69.1104 | The Planet Earth | 3 |
| T69.1107 | Statistical Methods in Meteorology and Oceanography | 3 |
| T69.1151 | Physical Oceanography | 3 |
| T69.1152 | Physical Oceanography | 3 |
| T69.1701 | Air Pollution Chemistry | 3 |
| T69.1702 | Air Pollution Analysis | 3 |
| T69.2201 | Weather Analysis | 3 |
| T69.2202 | Weather Analysis | 3 |
| T69.2203 | Dynamic Meteorology | 3 |
| T69.2204 | Dynamic Meteorology | 3 |
| T69.2206 | Atmospheric Radiation | 3 |
| T69.2207 | Atmospheric and Oceanic Turbulence | 3 |
| T69.2208 | Atmospheric and Oceanic Turbulence | 3 |
| T69.2209 | Wave Motions in the Atmosphere and in the Ocean | 3 |
| T69.2210 | Wave Motions in the Atmosphere and in the Ocean | 3 |
| T69.2211 | Weather Prediction | 3 |
| T69.2212 | Weather Prediction | 3 |
| T69.2215 | Methods of Theoretical Meteorology and Oceanography | 3 |
| T69.2216 | Methods of Theoretical Meteorology and Oceanography | 3 |
| T69.2217 | Special Topics in Meteorology | 3 |
| T69.2218 | Special Topics in Meteorology | 3 |
| T69.2219 | Physics of the Upper Atmosphere | 3 |
| T69.2220 | Physics of the Upper Atmosphere | 3 |
| T69.2221 | The Atmospheres of the Planets | 3 |
| T69.2222 | Geophysical Random Processes | 3 |
| T69.2224 | Radiometeorology | 3 |
| T69.2225 | Geophysical Hydrodynamics | 3 |
| T69.2226 | Geophysical Hydrodynamics | 3 |
| T69.2228 | Tropical Meteorology | 3 |
| T69.2230 | Meteorological Measurements by Rockets and Satellites | 3 |
| T69.2231 | Atmospheric Physics Laboratory | 3 |
| T69.2232 | Atmospheric Physics Laboratory | 3 |
| T69.2235 | Atmospheric Chemistry and Radioactivity | 3 |
| T69.2236 | Atmospheric Chemistry and Radioactivity | 3 |
| T69.2237 | Atmospheric Physics | 3 |
| T69.2238 | Atmospheric Physics | 3 |
| T69.2239 | General Circulation of the Atmosphere | 3 |
| T69.2251 | Special Topics in Oceanography | 3 |
| T69.2253 | Dynamic Oceanography | 3 |
| T69.2254 | Dynamic Oceanography | 3 |
| T69.2256 | Analysis and Forecasting of Ocean Waves | 3 |
| T69.2258 | Selected Problems in Oceanography | 3 |
| T69.2259 | The Oceans | 3 |
| T69.2261 | Oceanographic Field Research | 3 |
| T69.2262 | Oceanographic Field Research | 3 |
| T69.2263 | Analysis of Oceanographic Data | 3 |
| T69.2264 | Analysis of Oceanographic Data | 3 |
| T69.2267 | Oceanography for Engineers | 3 |
| T69.2268 | Oceanography for Engineers | 3 |
| T69.2269 | Oceanography and Space Technology | 3 |
| T69.2270 | Electromagnetic Properties of Seawater | 3 |
| T69.2272 | Transmission of Sound in Seawater | 3 |
| T69.2303 | Research Methods in Meteorology and Oceanography | 3 |
| T69.2304 | Research in Meteorology | 3 |

| | | |
|---|---|---|
| T69.2307 | Research for the Master's Thesis | 3 |
| T69.2308 | Research in Oceanography | 3 |
| T69.2727 | Dispersion of Pollutants in the Atmosphere | 3 |
| T69.2749 | Air Pollution Engineering Control | 3 |
| T69.2766 | Air Pollution Effects | 3 |
| T69.3305 | Advanced Research in Meteorology | 3 |
| T69.3306 | Advanced Research in Meteorology | 3 |
| T69.3309 | Advanced Research in Oceanography | 3 |
| T69.3310 | Advanced Research in Oceanography | 3 |

The instructional staff for the courses listed above consists of the following:

Miller, James E., M.S., Chairman and Professor of Meteorology.
Neumann, Gerhard, Dr. Rer. Nat., Professor of Oceanography.
Ooyama, Katsuyuki, Ph.D., Professor of Meteorology.
Pierson, Willard J., Jr., Ph.D., Professor of Oceanography.
Schotland, Richard M., Sc.D., Professor of Meteorology.
Spar, Jerome, Ph.D., Professor of Meteorology.
Friend, James P., Ph.D., Associate Professor of Atmospheric Chemistry.
Kirwan, Albert D., Jr., Ph.D., Associate Professor of Oceanography.
Deland, Raymond J., Ph.D., Research Associate Professor of Meteorology.
Posmentier, Eric S., Ph.D., Assistant Professor of Geophysics.
Cardone, Vincent J., Ph.D., Research Assistant Professor of Meteorology.

To obtain further information, address all inquiries directly to:

Chairman, Department of Meteorology and Oceanography
School of Engineering and Science
New York University
University Heights
Bronx, New York 10453

## NORTH CAROLINA STATE UNIVERSITY
### RALEIGH, NORTH CAROLINA

Marine science courses and related studies are offered on the Raleigh campus and at the following off-campus facilities:

1. The Pamlico Marine Laboratory is a newly established facility near Aurora, North Carolina. The primary research interests encompass the effects of man's activities on the estuarine and marine environment. The physical facilities include three laboratory buildings, a dormitory, and various research vessels, the largest of which is a 35-foot shrimp trawler. One building is furnished with two salt water flow-through systems for the maintenance and culture of estuarine organisms. Two large walk-in coolers are also available for temperature and photoperiod control. Six one-half acre ponds have been constructed for experimental work. These ponds are designed to simulate natural estuaries but are subject to environmental control. A large series of smaller pools with flow-through control is also available.
2. The Hatteras Marine Laboratory is located at the southern end of Hatteras Island, North Carolina. Both northern and southern faunas are found in adjacent waters. There are a main office laboratory building and a large dissecting room and facilities for maintaining live organisms. Research programs include population dynamics of marine fishes.
3. The Estuarine and Menhaden Research Laboratory at Beaufort, North Carolina, operated by the Bureau of Commercial Fisheries, is available for research activities through adjunct appointments of several staff members. Modern research laboratories with special facilities for irradiating and maintaining organisms are provided.
4. Harbor House Marine Sciences Center is located on the Intercoastal Waterway between Wilmington and Wrightsville Beach, North Carolina. This facility serves as an extension center for marine sciences but has the capability for providing space for small laboratory requirements and living accomodations for visiting researchers. A 24-foot inboard boat is available for survey or sampling work.
5. Through co-operative arrangements, the facilities at Duke University's Marine Laboratory at Beaufort, North Carolina, and the University of North Carolina's Institute of Marine Sciences at Morehead City, North Carloina, are available for research purposes. Arrangements can also be made to utilize the R/V ADVANCE II and UNDAUNTED that are operated by the Cape Fear Technical Institute at Wilmington, North Carolina.

The campus has a variety of digital and analog computer facilities available on campus. There are also remote terminals for access to the IBM system 360 model 75 that is operated by the Triangle Universities Computer Center.

The University offers both the Ph.D. and M.S. in Marine Sciences through cooperating Departments. The requirements for the major for the Ph.D. degree are determined by the student's advisory committee. Normally, these will include four of five core courses (General, Physical, Biological, and Chemical Oceanology, and Marine Geology). Other courses will be selected from the general listing of courses in areas related to Marine Science. A doctoral candidate will be expected to take the Marine Sciences Seminar at least twice during his period of study. A period of residence at a marine station or on an oceanographic cruise in a program approved by the supervisory committee is required. Requirements for the minor, the language, comprehensive examinations, admission to candidacy, the thesis, residence registration for dissertation, and final examinations are as provided in the regulations of the Graduate School as described in the Graduate Catalog.

The M.S. program is essentially similar to the doctoral program except that only three of the five core courses and one semester of seminar are required. Normally, a period of residence at the marine station or on an oceanographic cruise in a program approved by the student's advisory committee will be required. A thesis in a Marine Science-related area is required. Requirements for the minor, the language, admission to candidacy, residence, and final examinations are as provided in the regulations printed in the Graduate Catalog.

The following courses in Marine Sciences are offered primarily in four Departments:

Botany, Civil Engineering, Geosciences, and Zoology. Those courses in the primary area of marine sciences are designated as Oceanography courses and are organized in a non-departmental program. Opportunities for summer research are available at the coastal facilities.

CORE COURSES IN MARINE SCIENCES

| | | |
|---|---|---|
| MAS 487 | Physical Oceanography | 3 |
| MAS 529 | Biological Oceanography | 3 |
| MAS 584 | Marine Geology | 3 |
| MAS 591 | Oceanology Seminar | 1 |

ADDITIONAL COURSES

| | | |
|---|---|---|
| ZO 420 | Fishery Science I | 3 |
| ZO 621 | Fishery Science II | 3 |
| ZO 441 | Ichthyology | 3 |
| BO-ZO 442 | General Ecology | 4 |
| GY 486 | Weather and Climate | 2 |
| ZO 515 | Growth and Reproduction of Fishes | 3 |
| ZO 517 | Population Ecology | 3 |
| ZO 519 | Limnology | 4 |
| ZO 619 | Advanced Limnology | 3 |
| BO 574 | Phycology | 3 |
| MB 401 | General Microbiology | 4 |
| ZO 450 | Invertebrate Zoology | 4 |
| GY 452 | Exogenic Materials and Processes | 4 |
| GY 552 | Exploratory Geophysics | 3 |
| GY 563 | Applied Sedimentology | 3 |
| GY 567 | Geochemistry | 3 |
| SSC 553 | Soil Mineralogy | 3 |
| MAS 581 | Introduction to Oceanographic Engineering | 3 |
| MAS 471 | Undersea Vehicle Design | 3 |
| CE 517 | Water Transportation | 3 |
| CE 548 | Engineering Properties of Soils | 3 |
| CE 549 | Engineering Properties of Soils | 3 |
| CE 641 | Advanced Soil Mechanics | 3 |
| CE 642 | Advanced Soil Mechanics | 3 |
| EM 504 | Mechanics of Ideal Fluids | 3 |
| EM 505 | Mechanics of Viscous Fluids I | 3 |
| EM 612 | Mechanics of Viscous Fluids II | 3 |
| MAE 651 | Principles of Fluid Motion | 3 |
| MAE 431 | Thermodynamics of Fluid Flow | 3 |
| MAS 541 | Gravity Wave Theory | 3 |
| MAS 551 | Ocean Circulation | 3 |
| MAS 581 | Introduction to Oceanographic Engineering | 3 |
| MAS 601 | Advanced Physical Oceanography I | 3 |
| MAS 602 | Advanced Physical Oceanography II | 3 |
| MAS 605 | Advanced Geophysical Fluid Mechanics I | 3 |
| MAS 606 | Advanced Geophysical Fluid Mechanics II | 3 |
| MAS 613 | Perturbation Methods in Fluid Mechanics I | 3 |
| MAS 614 | Perturbation Methods in Fluid Mechanics II | 3 |

These course offerings are supplemented by courses in Marine Science offered by the University of North Carolina at Chapel Hill. Students normally enrolled in this joint program will take courses on each campus.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOCHEMISTRY

Longmuir, Ian S., M.B.B, Professor of Biochemistry

DEPARTMENT OF BOTANY

Cooper, Arthur W., Ph.D., Professor of Botany

DEPARTMENT OF CIVIL ENGINEERING

Amein, Michael, Ph.D., Associate Professor of Civil Engineering
Langfelder, Jay, Ph.D., Associate Professor of Civil Engineering
Machemehl, Jerry L., Ph.D., Assistant Professor of Civil Engineering
Wahls, Harvey E., Ph.D., Professor of Civil Engineering

DEPARTMENT OF ENGINEERING MECHANICS

Edwards, John A., Ph.D., Professor of Engineering Mechanics

DEPARTMENT OF FOOD SCIENCE

Webb, Neil B., Ph.D., Associate Professor of Food Science

DEPARTMENT OF GEOSCIENCES

Huang, Norden E., Ph.D., Assistant Professor of Geosciences
Knowles, Charles E., Ph.D., Assistant Professor of Geosciences
Leith, Carlton J., Ph.D., Professor and Head of Geosciences
Lyman, John, Ph.D., Professor of Geosciences
Saucier, Walter J., Ph.D., Professor of Meteorology and Geosciences
Smith, James R., M.S., Adjunct Assistant Professor of Oceanology
Welby, Charles W., Ph.D., Associate Professor of Geosciences

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Royster, Larry H., Ph.D., Professor of Mechanical and Aerospace Engineering
Williams, James C., III, Ph.D., Professor of Mechanical and Aerospace Engineering

DEPARTMENT OF SOIL SCIENCE

Woodhouse, William W., Ph.D., Professor of Soil Science

DEPARTMENT OF ZOOLOGY

Copeland, B. J., Ph.D., Associate Professor of Zoology
Hassler, William W., Ph.D., Professor of Zoology
Hayne, Don W., Ph.D., Professor of Zoology and Experimental Statistics
Hobbie, John E., Ph.D., Associate Professor of Zoology

ESTUARINE AND MENHADEN RESEARCH LABORATORY

Angelovic, Joseph W., Ph.D., Adjunct Assistant Professor of Zoology
Rice, Theodore R., Ph.D., Adjunct Professor of Zoology
Williams, Richard B., Ph.D., Adjunct Assistant Professor of Zoology
Wolfe, Douglas A., Ph.D., Adjunct Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Peele Hall
North Carolina State University
Raleigh, North Carolina 27607

## THE UNIVERSITY OF NORTH CAROLINA
### CHAPEL HILL, NORTH CAROLINA

The University of North Carolina at Chapel Hill (UNC-CH) and North Carolina State University at Raleigh (NCSU-R) cooperate to offer a Curriculum in Marine Sciences that involves several departments at each university. This description includes only the facilities and faculty at UNC-CH; see also the description of the NCSU-R program in this publication for full understanding of our joint program.

The University of North Carolina has teaching and research facilities on the campus at Chapel Hill, at the Institute of Marine Sciences at Morehead City, and at the Wrightsville Marine Biomedical Laboratory, Wilmington. Courses are taught on campus in several departments and research projects are also conducted in departmental laboratories. Special research facilities on campus include biological incubators; electron microscopes; gas chromatographs; infra-red spectrometer; liquid scintillation counters; gamma spectrometer; mass spectrometer; and computer center. The principle research facility, however, is the Institute of Marine Sciences. A new laboratory building providing 20,000 square feet of space was completed on the shore of Bogue Sound in 1968. The R/V MACHAPUNGA, a 48-foot diesel-powered vessel specially built for estuarine research, is equipped with radio-telephone, fathometer, generators for 100 v. a-c. and 32 v. d-c., and a hydraulic winch for handling gear; it has a 600 mile cruising range and living accommodations for four persons. Several outboard-powered small boats are available. Additional facilities at this coastal laboratory include a library, research collections of fishes, decapod crustaceans, and mollusks, photographic darkroom, radio-isotope facilities, a large pier, a running-saltwater system in a separate wing of the laboratory, large outdoor seawater tanks, and experimental seawater ponds. Research equipment includes microscopes, in situ salinometers, sampling bottles, nets, and trawls, pyreheliometers, submarine photometer, oxygen and carbon dioxide analyzers, histological equipment, gas chromatograph, spectrophotometers, and many other types of general laboratory equipments such as hoods, incubators, balances, centrifuges, and pH meters. Special equipment at Wrightsville Marine Biomedical Laboratory include pressure chambers to simulate terrestrial environments from +30,000 to -6,000 feet above sea level, together with apparatus and instrumentation for physiological and neurological studies; special problems in physical chemistry and strength of materials can also be undertaken.

The following degrees are offered:

1. Ph.D. in Marine Sciences (Curriculum in Marine Sciences). For the Ph.D. degree each student will ordinarily take at least four of the following courses, Oceanography (101), Physical Oceanography (122), Geological Oceanography (103), Biological Oceanography (104s), and Chemical Oceanography (105), although his committee may approve other courses as satisfactory substitutes. He must also take Seminar in Marine Sciences (206) at least twice and will study or do research at a marine laboratory or on an oceanographic cruise in a program approved by his committee. The dissertation will be on a marine topic. A minor is optional. A reading knowledge of two foreign languages is required; in some cases a research skill such as mathematics, statistics, or information science may be substituted for one language. Every student must gain some teaching experience during his program.

2. M.S. in Marine Sciences (Curriculum in Marine Sciences). For the M.S. degree each student must earn at least 30 semester hours of credit, including at least three of the courses listed above for the Ph.D. degree or substitute courses that are satisfactory to his committee. He must take Seminar in Marine Sciences (206) at least once, and a period of residence at a marine station or on an oceanographic cruise will ordinarily be required. A thesis on a marine topic is required. A minor is optional. A reading knowledge of one foreign language is required. Every student must gain some teaching experience during his program.

Courses in the marine sciences are offered during the academic year on the Chapel Hill campus and during the summer at the Institute of Marine Sciences and the Wrightsville Marine Biomedical Laboratory. These courses are sponsored by the Curriculum in Marine Sciences and by the departments of Botany, Environmental Sciences and Engineering, Geology, and Zoology.

GRADUATE COURSES

CURRICULUM IN MARINE SCIENCES

| | | |
|---|---|---|
| 101 | Oceanography | 3 |
| 103 | Geological Oceanography | 4 |
| 104s | Biological Oceanography | 6 |
| 105 | Chemical Oceanography | 3 |
| 105L | Chemical Oceanography Laboratory | 1 |
| 122 | Physical Oceanography | 3 |
| 141s | Special Problems in Marine Biology | 6 |
| 161s | Problems in Marine and Environmental Physiology | 2 |
| 206 | Seminar in Oceanography | 1 |
| 224 | Measurement in Oceanography | 2 |
| 226 | Physical Oceanography Seminar | 2 |
| 228 | Mathematics in Physical Oceanography | 3 |
| 239 | Micropaleontology--Foraminifera | 4 |
| 240s | Ichthyology | 6 |
| 300 | Research in Marine Sciences | 2-up |
| 393 | Master's Thesis | 3-up |
| 394 | Doctoral Dissertation | 3-up |

DEPARTMENT OF BOTANY

| | | |
|---|---|---|
| 215 | Marine Mycology | 6 |
| 217 | Algae II (Marine Algae) | 5 |
| 219 | Algal Physiology | 5 |

DEPARTMENT OF ENVIRONMENTAL SCIENCES AND ENGINEERING

| | | |
|---|---|---|
| 122 | Water Chemistry | 4 |
| 132 | Limnology and Water Pollution | 3 |
| 134 | Environmental Microbiology | 3 |
| 233 | Microbial Ecology | 4 |
| 235 | Ecology of Phytoplankton | 4 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 117 | Clay Mineralogy | 4 |
| 161 | Applied Geophysics | 4 |
| 162 | Applied Geophysics | 4 |
| 165 | Physics of the Earth | 3 |
| 247 | Sedimentation | 4 |
| 248 | Sedimentary Petrology | 4 |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| 109 | Introduction to Hydrobiology | 4 |
| 146 | Marine Ecology | 4 |
| 156 | Advanced Marine Invertebrate Zoology | 4 |
| 157 | Advanced Marine Invertebrate Zoology | 4 |
| 208A | Population Ecology | 3 |
| 213 | Advanced Marine Ecology | 3 |
| 265 | Seminar in Marine Biology | 2 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BOTANY

Hommersand, Max H., Ph.D., Associate Professor of Botany
Koch, William J., Ph.D., Associate Professor of Botany

DEPARTMENT OF ENVIRONMENTAL SCIENCES AND ENGINEERING

Johnson, J. Donald, Ph.D., Associate Professor of Environmental Chemistry
Kuenzler, Edward J., Professor of Environmental Biology
Lyman, John, Ph.D., Professor of Oceanography
Mah, Robert A., Ph.D., Associate Professor of Environmental Microbiology
Weiss, Charles M., Ph.D., Professor of Environmental Biology

DEPARTMENT OF GEOLOGY

Ingram, Roy L., Ph.D., Professor of Geology
Korgen, Benjamin J., Ph.D., Assistant Professor of Physical Oceanography
St. Jean, Joseph, Jr., Ph.D., Professor of Geology
Textoris, Daniel A., Ph.D., Associate Professor of Geology
Watkins, Joel S., Ph.D., Associate Professor of Geology

DEPARTMENT OF ZOOLOGY

Jenner, Charles E., Ph.D., Professor of Zoology
Riedl, Rupert, Dr. phil. habil., Kenan Professor of Zoology, Research Professor at the Institute of Marine Sciences
Stiven, Alan E., Ph.D., Associate Professor of Zoology

INSTITUTE OF MARINE SCIENCES

Chestnut, Alphonse F., Ph.D., Director of the Institute of Marine Sciences; Professor of Zoology
Kohlmeyer, Jan J., Dr. rer. Nat., Associate Professor in the Institute of Marine Sciences; Associate Professor of Botany
Schwartz, Frank J., Ph.D., Associate Professor in the Institute of Marine Sciences
Williams, Austin B., Ph.D., Professor in the Institute of Marine Sciences
Woods, William J., Ph.D., Associate Professor in the Institute of Marine Sciences; Associate Professor of Botany

WRIGHTSVILLE MARINE BIOMEDICAL LABORATORY

Brauer, R.W., Ph.D., Director of Wrightsville Marine Biomedical Laboratory; Visitng Professor of Physiology

To obtain further information, address all inquiries directly to:

Dr. Edward J. Kuentzler
Curriculum in Marine Sciences
Hobbs House
University of North Carolina
Chapel Hill, North Carolina 27514

## NORTHEASTERN ILLINOIS STATE COLLEGE
### CHICAGO, ILLINOIS

The oceanography program is an interdepartmental offering. Coastal aspects of oceanography are taught during summer "Sea Camps", field programs operated in Ensenada (Baja California, Mexico) through special arrangements with the Escuela Superior de Ciencias Marinas of the Universidad Autonoma de Baja California. A vessel of the Mexican Coast Guard provides shipboard experience. Similar arrangements with emphasis on geological and biological aspects of ocean study have been made with the Station de Biologie Marine of the Université de Bordeaux at Arcachon (France). The Station has two small vessels at its disposal. Since 1970, the research facilities, laboratories and vessels of the Centre of Marine Research, National Council of Scientific Research of Roumania have been placed at the College's disposal; the program is conducted at Mamaia, on the Black Sea. The Centre d' Oceanographie et Station Marine d' Endoume of the Université d' Aux-Marseille (France) is also available and a Sea Camp will henceforth be held there as well; Endoume has a large trawler at its disposal.

Students are further encouraged to attend summer sessions at oceanographic stations.

The College does not offer a program leading to undergraduate or advanced degrees in the marine sciences. The undergraduate students, interested in oceanography, may follow a program leading to a B.A. degree in the earth sciences or geography, with a concentration in oceanography. The graduate students may obtain an M.A. in geography or earth sciences with concentration in oceanography. The "concentration" consists of a minimum of 15 hours in oceanography or marine science courses.

1. B.A. in Geography. Nine semester hours in each of the following areas: physical geography, human geography and six hours in regional geography and six hours of geography electives. The electives and six of the nine hours of physical geography may be taken in marine science courses.

2. B.A. in Geography--Secondary Education. Six hours in each of physical, topical, regional geography and twelve hours of electives. The electives and three hours of physical geography may be taken in marine science courses.

3. B.A. in Geography--Elementary Education. Three hours in each of physical, eco-

nomic, cultural and Anglo-American geography, plus twelve hours of geography electives. The electives may be taken in marine science courses.

4. B.A. in Earth Science--Elementary Education. Three hours in each of the following: Earth Science, Meteorology, Economic Geology and Astronomy; twelve hours of electives of which three may be in oceanography.

5. M.A. in Geography. The requirements include 27 credits in geography and six for thesis. Three courses (3 credits each) are required: Cartography, Statistics for Earth Sciences and Geography; and Scope and Philosophy of the Geographical Sciences. The remaining 18 credits may be taken in marine science courses, and the program must be organized systematically under the guidance of the faculty advisor. The thesis should be written in an area of concentration. A final examination is administered by the faculty of the Geography Department.

6. M.A. in the Teaching of Geography. Course requirements are 18 credits in geography - nine in education and six for thesis. The thesis requirements are the same as those for the M.A. in Geography. The only required geography course is Scope and Philosophy of the Geographical Sciences (3 credits). The three education courses totaling nine credits are Principles of Curriculum Development; Television and Related Instructional Media; and Research in the Classroom Teaching of Geography. The remaining 15 credits may all be taken in marine sciences courses.

Students may substitute for a thesis two major research papers to be written under the guidance of two geography faculty members. However, in such cases, six additional credits must be taken in geography courses (marine sciences courses qualify also), and the degree will be considered terminal rather than leading to further studies.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| 41-315 | Field Seminar (Oceanography) | 3 |
| 43-318 | Conservation of Natural Resources | 3 |
| 43-422 | Paleography | 3 |
| 43-343 | Polar Geography | 3 |
| 43-351 | Statistics for Earth Science and Geography | 3 |
| 43-352 | Guided Study in Geography-Oceanography | 1-3 |
| 43-373 | Biological Geography (Oceanography) | 3 |
| 43-374 | Cartography | 3 |
| 43-442 | Geographic Problems in Quantitative Measurements | 3 |
| 43-421 | Climatology | 3 |
| 43-431 | Thesis Seminar | 3 |
| 43-441 | Mathematical Geography | 3 |
| 53-372 | Fundamentals of Meteorology and Climatology | 3 |
| 53-313 | Stratigraphy and Sedimentology | 5 |
| 53-318 | World Regional Geology | 3 |
| 53-321) 43-324) | Oceanography I | 3 |
| 43-325 | Oceanography II | 3 |
| 53-324 | History of the Geological Sciences | 3 |
| 53-325 | Seminars in Earth Science | 3 |
| 53-326 | Individual Study in Earth Science | 3 |
| 56-317 | Ecology | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOGRAPHY

Charlier, Patricia S., Ph.D., Visiting Professor of Geographic and Marine Science Education
Charlier, Roger H., Ph.D., Sc.D., Vice-Chairman and Professor of Geology, Geography and Oceanography, Director oceanography programs
Contescu, Lorin R., Dr. Geol., Dr. Ing., Visiting Professor of Geomorphology and Paleogeography
De Julio, Emil, M.A., Lecturer in Methodology of Geography and Oceanography
Dierickx, C. Wallace, Ph.D., Chairman and Professor of Geography
Easton, Robert, M.A., Instructor in Geography
Haug, James, M.A., Lecturer in Geography
Mulmat, Kenneth, M.A., Instructor in Geography and Computer Science
Murphy, Br., F., Lecturer in Biological and Chemical Oceanography
Odell, Clarence B., Ph.D., Visiting Professor of Cartography
Portenlanger, John, B.A., Assistant in Oceanography
Rathjen, Randall, Ph.D., Assistant Professor of Geography
Winston, Barbara, M.A., Instructor in Physical Geography

DEPARTMENT OF PHYSICAL SCIENCES

Doehler, C., Ph.D., Associate Professor of Geology
Forslev, Albert, Ph.D., Professor of Earth Sciences
Qutub, Musa, Ph.D., Assistant Professor of Earth Sciences

DEPARTMENT OF BIOLOGY

Betz, Robert F., Ph.D., Professor of Biology
Wiercinski, Floyd J., Ph.D., Professor of Biology

Universities of Baja California, Mamaia, Aux-Marseille and Bordeaux.

The staffs teach the "Sea Camps". They are under the direction of:

Ceccaldi, Hubert, Doctor in Oceanographie, Director adjaint de la station d' Endounie (Aux-Marseille)
Diegues-Corvarrubias, Armando, Professor of Oceanography (Baja California)
Cazaux, S., Docteur in Oceanographie, Tous-Directeur de la Station d' Arcachon (Bordeaux)
Fordanescue, H., Dr. Ing., Director, Roumanian Center of Marine Research (Mamaia)

To obtain further information, address all inquiries directly to:

Dr. Roger H. Charlier, Director
Oceanography Programs; Room C630
Northeastern Illinois State College
5500 North St. Louis Avenue
Chicago, Illinois 60625

## NORTHEASTERN UNIVERSITY
BOSTON, MASSACHUSETTS

The University offers marine science courses at both its main campus and at its

Marine Science Institute at Nahant, Massachusetts. The Marine Science Institute was opened in 1966. It occupies 22 acres at the tip of Nahant projecting into Massachusetts Bay. In addition to small boats, a 34-foot work-boat is utilized for hydrological studies. The Institute serves as a research center for laboratory and field studies primarily by the Eastern Massachusetts academic community. In addition, a course in Ocean Chemistry is offered at the Institute during the academic year, and a series of courses designed to prepare students for research in biological areas are offered in the summer on a national basis for qualified students.

The following degrees are offered:

1. M.A. and Ph.D. in Biology with Marine Science options.
2. M.A. and Ph.D. in Chemistry with Marine Science options.

The following courses are offered in conjunction with the above programs. Credits are in quarter hours.

MARINE SCIENCE INSTITUTE

UNDERGRADUATE COURSE

| | | |
|---|---|---|
| 12.180 | Chemical Oceanography | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| 18.804 | Lower Invertebrates | 4 |
| 18.805 | Coelomate Invertebrates | 4 |
| 18.810 | Ichthyology | 4 |
| 18.830 | Marine Algae | 4 |

COLLEGE OF LIBERAL ARTS

UNDERGARDUATE COURSE

DEPARTMENT OF BIOLOGY

18.210 Invertebrate Zoology

DEPARTMENT OF CHEMISTRY

12.180 Chemical Oceanography

DEPARTMENT OF EARTH SCIENCES

16.131 Physical Oceanography
16.132 Biological Oceanography

GRADUATE COURSES

DEPARTMENT OF BIOLOGY

18.804 Lower Invertebrates
18.805 Coelomate Invertebrates
18.806 Malacology
18.811 Human Ecology
18.812 Dynamics of Aquatic Ecology
19.905 Marine Microbiology

UNIVERSITY COLLEGE (EVENING)

UNDERGRADUATE COURSES

16.531 Oceanography I
16.532 Oceanography II
16.533 Marine Geology
16.534 Fisheries Oceanography I
16.535 Fisheries Oceanography II
16.536 Fisheries Oceanography III
18.804 Lower Invertebrates
18.805 Coelomate Invertebrates
18.806 Malacology
18.811 Human Ecology
18.812 Dynamics of Aquatic Ecology
18.095 Marine Microbiology

The University also offers undergraduate and graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

MARINE SCIENCE INSTITUTE

Collette, Bruce B., Ph.D., Assistant Laboratory Director, Bureau of Commerical Fisheries, U.S. National Museum.
Morse, M. Patricia, Ph.D., Associate Professor of Biology
Riser, Nathan W., Ph.D., Professor of Biology, Director, Marine Science Institute
Webber, Edgar E., Ph.D., Assistant Professor of Biology, Keuka College
Jankowski, Conrad, Ph.D., Associate Professor of Chemistry

COLLEGE OF LIBERAL ARTS

DEPARTMENT OF BIOLOGY

Crisley, Francis D., Ph.D., Professor and Chairman
Morse, M. Patricia, Ph.D., Associate Professor
Moyer, Samuel E., Ph.D., Assistant Professor
Rosenberg, Fred A., Ph.D., Associate Professor
Ruber, Ernest, Ph.D., Associate Professor

DEPARTMENT OF CHEMISTRY

Weiss, Karl, Ph.D., Chairman
Jankowski, Conrad M., Ph.D., Associate Professor

DEPARTMENT OF EARTH SCIENCES

Overcash, J. Rosson, A.M.T., Chairman
Gordon, Bernard L., M.Sc., Associate Professor
Ruggles, Richard D., M.A., Assistant Professor

To obtain further information, address all inquiries directly to:

MARINE SCIENCE INSTITUTE

Professor Nathan W. Riser
Marine Science Institute
Northeastern University
East Point
Nahant, Massachusetts 01908

GRADUATE LIBERAL ARTS

Dr. Robert Ketchum
College of Liberal Arts
Northeastern University
Boston, Massachusetts 02115

UNDERGRADUATE

Professor Bernard L. Gordon
Department of Earth Sciences
Northeastern University
Boston, Massachusetts 02115

## NOVA UNIVERSITY
## OCEANOGRAPHIC LABORATORY
### FORT LAUDERDALE, FLORIDA

The Oceanographic Laboratory is part of the Physical Science Center of the University. It is housed in a waterfront facility in the Port Everglades area. Classroom and laboratory facilities are available for programs in physical, chemical and biological oceanography. The laboratory operates two small research vessels.

The University offers the Ph.D. degree in Physical Oceanography, Chemical Oceanography, Marine Biology or Physics with a dissertation in Oceanography.

Numbered courses with a specified number of credits are not given. The program for each student is adjusted to his needs and background. Pregraduate and survey courses are not given. Instruction is offered in all phases of physical and chemical oceanography and related parts of marine biology. Students are expected, upon completion of their studies, to be conversant with the latest developments in these fields. Dissertation research normally involves work at sea.

The instructional staff for the courses listed above consists of the following:

Baig, Stephen, Assistant Professor of Marine Biochemistry
Carritt, Dayton E., Professor of Oceanography
Herndon, Roy C., Associate Professor of Physics
Moore, Dennis W., Assistant Professor of Theoretical Oceanography
Niiler, Pearn P., Associate Professor of Theoretical Oceanography
Powers, Walter E., Post Doctoral Fellow in Physics
Richardson, William S., Professor of Oceanography
Snyder, Russell L., Associate Professor of Oceanography
Spillane, Michael A., Post Doctoral Fellow in Fluid Dynamics
Yaeger, Robert F., Post Doctoral Fellow in Fluid Dynamics

To obtain further information, address all inquiries directly to:

Dr. William S. Richardson
Oceanographic Laboratory
1901 S.E. 15th Street
Fort Lauderdale, Florida 33316

## OLD DOMINION UNIVERSITY
## INSTITUTE OF OCEANOGRAPHY
### NORFOLK, VIRGINIA

The Institute occupies a building on the campus of Old Dominion with laboratories for physical, chemical, geological, and biological oceanography. It maintains docking facilities at the Naval Amphibious Base at Little Creek, Virginia Beach, Virginia. A 65-foot former Army T-boat is being obtained and outfitted as a research vessel. It will house oceanographic winches, sampling equipment, and laboratory facilities. The Institute has access to larger vessels for work at sea such as the NASA vessel RANGE RECOVERER, the NSF vessel, EASTWARD, and the Coast Guard vessels, CHEROKEE and ROCKAWAY.

In 1965 the Institute was formally separated from its parent body; which however, continues to pursue marine biological investigations. The Virginia state council of higher education visualizes the ODU Institute of Oceanography as an academic counterpart of the fisheries-oriented activities of the Virginia Institute of Marine Science. Hence, while a biological major is offered, the Institute emphasizes the physical marine sciences.

In order to qualify for a degree of Master of Science with a concentration in Oceanography, a student must meet the following requirements:

1. He must have satisfied the various degree requirements established by the university and stated in the catalog.
2. He must complete a minimum of 28 semester hours exclusive of research and thesis, plus an additional 3 hours of each of the latter two subjects. With the permission of the director, as many as nine hours of credit may be allowed for work in graduate courses in other departments. Fifteen hours of credit must be obtained from the core courses, two from seminar, and twelve hours credit must be obtained from 500 level courses pertinent to the student's specialization. A course in statistics is required.
3. The student must complete a thesis which demonstrates his capacity to conduct independent research. He must pass a final comprehensive examination which will be an oral and/or written examination on his thesis and closely related topics.

The following courses are offered in conjunction with the above program:

GRADUATE COURSES

INSTITUTE OF OCEANOGRAPHY

| | | |
|---|---|---|
| 501 | Oceanographic Analysis | 3 |
| 504* | Physical Oceanography I | 3 |
| 505* | Physical Oceanography II | 3 |
| 506 | Dynamic Oceanography | 3 |
| 507 | Waves and Tides | 3 |
| 510* | Chemical Oceanography | 3 |
| 512 | Advanced Chemical Oceanography | 3 |
| 520* | Geological Oceanography | 3 |
| 525 | Dynamics of Marine Sedimentation | 3 |
| 528 | Marine Sediments | 3 |
| 532 | Geochemistry of the Oceans | 3 |
| 540* | Biological Oceanography | 3 |
| 541 | Marine Phycology | 3 |
| 542 | Marine Mycology and Microbiology | 3 |
| 543 | Physiology of Marine Plants | 3 |
| 591* | Seminar | 1 |
| 592* | Seminar | 1 |
| 595 | Special Topics in Oceanography | 3-6 |
| 596 | Special Topics in Oceanography | 3-6 |
| 598* | Research | 1-9 |
| 599* | Thesis | 1-9 |

*Required Courses

BIOLOGY DEPARTMENT

| | | |
|---|---|---|
| 415 | Marine Ecology | 4 |
| 419 | Marine and Estuarine Plankton | 4 |
| 420 | Ichthyology | 4 |
| 430 | Marine Science | 4 |

CHEMISTRY DEPARTMENT

| | | |
|---|---|---|
| 415 | General Chemical Oceanography | 3 |

The instructional staff for the courses listed above consists of the following:

Johnson, Ronald E., Ph.D., Assistant Professor of Oceanography
Ludwig, John C., Ph.D., Slover Professor of Oceanography; Director, Institute of Oceanography
Slowey, J. Frank, Ph.D., Smith Associate Professor of Oceanography
Swift, Donald J.P., Ph.D., Slover Associate Professor of Oceanography
Zaneveld, Jacques S., Ph.D., D.Sc., Slover Professor of Oceanography

SUPPORTING DEPARTMENTS

Birdsong, Ray S., Ph.D., Professor of Biology
Gosink, Thomas A., Ph.D., Associate Professor of Chemistry
Marshall, Harold G., Ph.D., Professor of Biology; Chairman, Department of Biology
Shideler, Gerald L., Ph.D., Assistant Professor of Geophysical Sciences

To obtain further information, address all inquiries directly to:

Dr. C. Burgess
Dean of Graduate Studies
Old Dominion University
Norfolk, Virginia 23508

## OREGON STATE UNIVERSITY
### CORVALLIS, OREGON

Course work is offered on the main campus in Corvallis where the Department of Oceanography occupies two buildings. A four-story building having 30,000 square feet of research laboratory and office space was completed in 1964. A three-story research laboratory and office building having 25,000 feet of floor space was completed in 1970. Adjacent temporary buildings are used for special projects and departmental machine shops.

At Newport, the Marine Science Center (completed in 1965) is used by several departments at Oregon State University. It consists of three wings; one contains a public aquarium, museum, and auditorium; another is used for fisheries and pollution research; and the third is used for basic research in oceanography and zoology.

Docking and support facilities for ocean research vessels and for small boats are adjacent to the Marine Science Center, on Yaquina Bay. Two ocean going research vessels are based in Newport. The 180-foot R/V YAQUINA and the 80-foot R/V CAYUSE. Both ships are equipped for all types of marine research. The YAQUINA (having eight laboratories and space for 18 scientists) is used primarily for deep ocean work and is used for long cruises. The CAYUSE has three laboratories and space for seven scientists. She is used mostly for work over the continental shelf and in inshore waters.

Smaller research craft include the 33-foot R/V PAIUTE (based in Newport) and the 37-foot R/V SACAJAWEA (based in Astoria, Oregon). Both of these vessels are used for estuarine and coastal research along with other small craft with outboard motors.

The Oceanography Department offers the M.A., M.S., and Ph.D. degrees with specialization in physical, biological geological, chemical and geophysical oceanography. All students are required to spend at least ten days at sea on board one of the research ships each year.

1. M.S. or M.A. in Oceanography. A minimum of 45 hours including thesis work is required for the master's program. Approximately two-thirds of the work must be taken in the oceanography department. In special cases the thesis requirement may be waived.

All oceanography majors are required to take a set of core courses which must include two courses in descriptive physical oceanography (Oc 531 and Oc 532) and one course each in biological (Oc 441 or approved substitute), geological (Oc 461 or approved substitute), and chemical (Oc 451 or Oc 552) oceanography. The remainder of the program is made up of courses in the student's field of specialization.

No foreign language is required for the M.S. degree. For the M.A. degree the student must show, by examination or by adequate undergraduate courses (not less than two years), a reading knowledge of one foreign language (usually Russian, German or French).

Candidates must pass a two hour final oral examination in which they defend their theses.

2. Ph.D. in Oceanography. The core courses required for the M.S. or M.A. program are also required for the Ph.D. program. Credits earned in the M.S. or M.A. program may be transferred into the Ph.D. program. The remainder of the Ph.D. program is determined by the individual student and his committee. A student must satisfy the foreign language requirements established by his committee (reading ability in at least one foreign language is required). Ph.D. candidates must pass a written departmental comprehensive examination (based on the oceanography core courses), a University preliminary examination on the Ph.D. program, and a final oral thesis defense.

3. M.S., M.A., and Ph.D. in Geophysics. Programs in geophysics are offered within the Department of Oceanography and in cooperation with the Departments of Physics, Geology, and Mathematics. A student studying for a degree under this program works out a course of study upon consultation with his committee. This program must include a minimum of three courses in oceanography. The remainder of the program is selected from geophysics courses Oc 480, Oc 507, Oc 580, 581, 582, 583, 584, 586 and 589 and/or from related fields.

Examination procedures and foreign language requirements are the same as for other oceanography specialty degrees.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSE

| | | |
|---|---|---|
| Oc 331 | Introduction to Oceanography | 3 |

GRADUATE COURSES

| | | |
|---|---|---|
| Oc 441 | Biological Oceanography | 4 |

| | | |
|---|---|---|
| Oc 442 | Marine Zooplankton | 5 |
| Oc 451 | Chemical Oceanography | 4 |
| Oc 461 | Geological Oceanography | 4 |
| Oc 471 | Physical Limnology | 3 |
| Oc 480 | Marine Geophysics | 3 |
| Oc 501 | Research | arr. |
| Oc 501 | Research: Gamma Ray Spectrometry | arr. |
| Oc 503 | Thesis | arr. |
| Oc 505 | Reading and Conference | arr. |
| Oc 507 | Seminar | arr. |
| Oc 507 | Seminar: | |
| | Readings in Biological Oceanography | 1 |
| | Readings in Chemical Oceanography | 1 |
| | Readings in Geophysics | 1 |
| | Marine Radioecology | 1 |
| Oc 521 | Marine Radioecology | 3 |
| Oc 529 | Special Topics in Marine Radioecology | 1-3 |
| Oc 531 | Descriptive Physical Oceanography I | 4 |
| Oc 532 | Descriptive Physical Oceanography II | 4 |
| Oc 542 | Marine Nekton | 3 |
| Oc 543 | Marine Nekton Laboratory | 1 |
| Oc 544 | Marine Phytoplankton Ecology | 3 |
| Oc 545 | Marine Phytoplankton Physiology | 3 |
| Oc 546 | Marine Primary Production | 5 |
| Oc 548 | Marine Benthic Ecology | 4 |
| Oc 549 | Special Topics in Biological Oceanography | 1-3 |
| Oc 552 | Chemical Oceanography | 4 |
| Oc 553 | Descriptive Chemical Oceanography | 4 |
| Oc 554 | Theoretical Chemical Oceanography | 4 |
| Oc 559 | Special Topics in Chemical Oceanography | 1-3 |
| Oc 561 | Geology of Ocean Basins | 3 |
| Oc 562 | Marine Geology of the Continental Margin | 3 |
| Oc 563 | Deep-Sea Sediments | 3 |
| Oc 564 | Mineralogy of Marine Sediments | 3 |
| Oc 565 | Stratigraphy of Marine Sediments | 3 |
| Oc 566 | Ecology of Foraminifera | 3 |
| Oc 567 | Marine Micropaleontology I: Foraminifera | 4 |
| Oc 568 | Marine Micropaleontology II: Radiolaria and Calcareous Nannoplanktons | 4 |
| Oc 569 | Special Topics in Geological Oceanography | 1-3 |
| Oc 571 | Theoretical Physical Oceanography I | 4 |
| Oc 572 | Theoretical Physical Oceanography II | 4 |
| Oc 573 | Theoretical Physical Oceanography III | 4 |
| Oc 574 | Wave Dynamics | 4 |
| Oc 575 | Marine Hydrodynamics | 4 |
| Oc 579 | Special Topics in Physical Oceanography | 1-3 |
| Oc 580 | Theoretical Geophysics: Sound Transmission | 2 |
| Oc 581 | Theoretical Geophysics: Earth Gravity | 3 |
| Oc 582 | Theoretical Seismology | 3 |
| Oc 583 | Earthquake Seismology | 3 |
| Oc 584 | Physics of the Earth | 3 |
| Oc 586 | Theoretical Geophysics: Magnetics | 3 |
| Oc 589 | Special Topics in Geophysics | 1-3 |

The University also offers undergraduate and graduate programs in Food Science and Technology and graduate programs in Fisheries Science and Ocean Engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Beardsley, George F., Jr., Ph.D., Associate Professor
Bodvarsson, Gunnar, Ph.D., Professor
Burt, Wayne V., Ph.D., Associate Dean of Research and Director, Marine Science Center
Byrne, John V., Ph.D., Department Chairman
Caldwell, Douglas R., Ph.D., Assistant Professor
Carey, Andrew G., Ph.D., Assistant Professor
Couch, Richard, Ph.D., Assistant Professor
Crew, Henry, Ph.D., Research Associate
Curl, Herbert, Jr., Ph.D., Professor
Cutshall, Norman, Ph.D., Research Associate
Dymond, Jack, Ph.D., Assistant Professor
Elliott, William P., Ph.D., Research Associate
Forster, William O., Ph.D., Assistant Professor
Fowler, Gerald A., Ph.D., Assistant Professor
Frolander, Herbert F., Ph.D., Professor
Gonor, Jefferson, Ph.D., Assistant Professor
Gordon, Louis I., M.S., Instructor
Heath, G. Ross, Ph.D., Assistant Professor
Hedgpeth, Joel W., Ph.D., Professor and Resident Director, Marine Science Center
Heinrichs, Donald, Ph.D., Assistant Professor
Komar, Paul D., Ph.D., Assistant Professor
Kulm, Lavern D., Ph.D., Associate Professor
McCauley, James E., Ph.D., Associate Professor
Mesecar, Roderick S., Ph.D., Assistant Professor
Miller, Charles B., Ph.D., Assistant Professor
Moore, Ted C., Ph.D., Assistant Professor
Morita, Richard, Ph.D., Professor
Nath, John H., Ph.D., Research Associate
Neal, Victor T., Ph.D., Assistant Professor
Neshyba, Stephen J., Ph.D., Associate Professor
Park, P. Kilho, Ph.D., Associate Professor
Pattullo, June G., Ph.D., Professor
Pearcy, William G., Ph.D., Professor
Pond, G. Stephen, Ph.D., Associate Professor
Pytkowicz, Ricardo M., Ph.D., Professor
Quinn, William H., Ph.D., Research Associate
Renfro, William C., Ph.D., Assistant Professor
Small, Lawrence F., Ph.D., Associate Professor
Smith, Robert L., Ph.D., Associate Professor
van Andel, Tjeerd H., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Victor T. Neal
Student Advisor
Department of Oceanography
Oregon State University
Corvallis, Oregon 97331

## UNIVERSITY OF OREGON
## OREGON INSTITUTE OF MARINE BIOLOGY
### EUGENE, OREGON

The University offers marine biology courses at both its main campus in Eugene and at Oregon Institute of Marine Biology, Charleston, Oregon. A modern science building at Eugene includes laboratory facilities for departments of biology, chemistry, molecular biology and physics.

Oregon Institute of Marine Biology is located on about 85 acres along Coos Bay at Charleston, Oregon. The Institute buildings include dormitories, dining hall, classrooms, and laboratories. There are six laboratory classrooms, with running salt water, study tables and benches, and lamps.

No degrees are offered by the Institute; however, the University of Oregon awards credit, including graduate credit for all courses designated (G) or at the 500 level. Work done at the Institute may form an integral part of the work towards Bachelor's, Master's, or Doctor's degrees in Biology offered on the Eugene campus.

Courses in the marine sciences are offered during the regular year at the main campus by the Department of Biology and Graduate School. The Department of Biology and the Graduate School also offer both regular summer and special workshop courses at the Institute of Marine Biology, Charleston. Independent studies and research have been carried out on a year around basis at the Institute since 1968.

The following courses are offered at the Institute:

| | | |
|---|---|---|
| Bi 413 | Comparative Physiology (G) | 8 |
| Bi 461 | Invertebrate Zoology (G) | 8 |
| Bi 465 | Comparative Biochemistry (G) | 8 |
| Bi 401 | Research | |
| Bi 501 | Research | |
| Bi 403 | Thesis | |
| Bi 503 | Thesis | |
| Bi 407 | Seminar | 2 |
| Bi 507 | Seminar | 2 |
| Bi 408 | Laboratory Projects | |

The instructional staff for the courses listed above consists of the following:

Dersham, George H., M.S., Research Associate
Frank, Peter W., Ph.D., Professor of Biology
McConnaughey, Bayard H., Ph.D., Associate Professor of Biology
Rudy, Paul P., Ph.D., Director, Oregon Institute of Marine Biology, and Assistant Professor of Biology
Terwilliger, R. C., Ph.D., Assistant Director, Assistant Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Paul P. Rudy, Director
Oregon Institute of Marine Biology
Charleston, Oregon 97420

## UNIVERSITY OF THE PACIFIC
### STOCKTON, CALIFORNIA
### AND THE
## PACIFIC MARINE STATION
### DILLON BEACH, CALIFORNIA

The Pacific Marine Station provides opportunities for study and research in marine biology and related fields of science. The facilities include laboratories, a library, a research museum, darkrooms, and living accommodations. A 34-foot, twin diesel, steel research vessel, BLACK SWAN; a 16-foot Boston Whaler; a 26-foot whaleboat, and various smaller boats are available.

The Department of Biological Sciences offers course work at the undergraduate level that would enable a student to prepare himself for a graduate degree program at the Pacific Marine Station. A student wishing to study and do research in the marine biology area would normally transfer to the Station late in his undergraduate program or upon graduation with a B.A. in Biology from the main campus.

The University also offers the degree of Master of Science. A minimum of 30 units must be completed for the degree, of which at least 16 must be selected from graduate course offerings in the Department of Biological Sciences (including four units of thesis). The remaining 14 units of course work may be selected from other offerings within the University with approval of the student's graduate committee. Candidates must pass an oral examination in Biology and demonstrate a reading knowledge of at least one of the following: French, German, Russian, or Spanish. An acceptable thesis in the area of the student's major interest is required. For further details consult the Graduate School Bulletin, University of the Pacific.

During the academic year there are opportunities for advanced study in problems of marine ecology and invertebrate zoology. Undergraduate and graduate courses are offered during the summer sessions on a nonmatriculation basis. These courses are accepted by many University departments in fulfillment of advanced degree requirements for study at a marine station. Usually three formal courses are offered during the ten week summer session, all of which are given by visiting instructors from other institutions.

Students from other colleges who desire to study at Pacific Marine Station should plan to begin their program by attending classes at the Station during the summer session before taking up academic year residence at Dillon Beach; formal admission procedures may be deferred until the fall semester.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGICAL SCIENCES

UNDERGRADUATE/GRADUATE COURSES

| | |
|---|---|
| 110 | Introduction to Marine Science |
| 116 | Aquatic Biology |
| 173 | Marine Natural History |
| 191 | Independent Study |
| 193 | Special Topics |
| 291 | Independent Graduate Study |
| 293 | Special Topics |
| 294 | Rsearch |



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PACIFIC MARINE STATION

GRADUATE COURSES (REGULAR SESSION)

| | |
|---|---|
| 213 | Advanced Invertebrate Zoology |
| 219 | Comparative Histology and Microtechnique |
| 294 | Directed Studies |
| 235 | Introduction to Oceanography |
| 245 | Ecological Physiology |
| 296 | Graduate Seminar |

UNDERGRADUATE/GRADUATE COURSES (SUMMER SESSION)

| | |
|---|---|
| S112 | Invertebrate Zoology |
| S124 | Marine Botany (Algology) |
| S137 | Marine Paleontology |
| S127 | Ichthyology |

The instructional staff for the courses listed above consists of the following:

Brice, Arthur T., M.A., Adjunct Professor of Microbiology, University of the Pacific (Pacific Marine Station)
Johnson, Ralph G., Ph.D., Adjunct Professor of Paleontology, University of the Pacific (Pacific Marine Station); Associate Professor of Paleontology, University of Chicago
Kaill, W. Michael, Ph.D., Assistant Professor, University of the Pacific
Loosanoff, Victor L., Ph.D., Adjunct Professor of Marine Biology, University of the Pacific (Pacific Marine Station)
Marcus, Stanley J., E.M., Associate to the Director, Assistant Professor of Oceanography
Smith, Edmund H., Ph.D., Director, Pacific Marine Station; Associate Professor of Zoology, University of the Pacific
Tucker, John S., Ph.D., Research Associate Professor, Pacific Marine Station; Associate Professor of Natural Science, Raymond College
Underhill, Raymond A., Ph.D., Research Associate

To obtain further information, address all inquiries directly to:

Edmund H. Smith, Director
Pacific Marine Station
Dillon Beach, Marin County,
California 94929

M. Dale Arvey, Chairman
Department of Biological Sciences
University of the Pacific
Stockton, California 95204

## PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK, PENNSYLVANIA

The following specialized facilities are available at the University: laboratory in marine geology; special meteorological equipment for courses in marine meteorology; special aquaria and field stations for the cultivation and study of fresh water fish; laboratory for underwater acoustics.

No formal degree programs are offered in marine science. However, baccalaureate and advanced degrees are offered in the allied fields of geological sciences (geology, geophysics, mineralogy, and geochemistry), meteorology, geography, biology and physics. Students who are candidates for degrees in these disciplines can schedule certain courses in the marine sciences.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| Bio 410 | General Limnology | 3 |
| Bio 480 | Marine Biology | 4 |
| Bio 481 | Aquatic Botany | 3 |

DEPARTMENT OF GEOCHEMISTRY

| | | |
|---|---|---|
| Gchem 522 | Geochemistry of Aqueous Systems | 3 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| Geol 440 | Marine Geology | 3 |
| Geol 540 | Chemical Oceanography | 3 |

DEPARTMENT OF METEOROLOGY

| | | |
|---|---|---|
| Met 320 | The Oceans | 2 |
| Met 445 | Hydrology for Meteorologists | 3 |
| Met 507 | Dynamic Oceanography | 2 |

DEPARTMENT OF PHYSICS

| | | |
|---|---|---|
| Phys 443 | Intermediate Acoustics | 3 |
| Phys 533 | Theoretical Acoustics | 3 |

Courses carrying a 400 number may be scheduled by undergraduate and graduate students; those carrying a 500 number can be scheduled only by graduate students.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Butler, Robert L., Ph.D., Associate Professor
Cooper, Edwin L., Ph.D., Professor
Dunson, William A., Ph.D., Assistant Professor

DEPARTMENT OF GEOCHEMISTRY

Barnes, Hubert L., Ph.D., Professor Geochemistry

DEPARTMENT OF GEOLOGY

Schmalz, Robert F., Ph.D., Professor, Marine Geology

DEPARTMENT OF METEOROLOGY

Blackadar, Alfred K., Ph.D., Professor, Meteorology
Panofsky, Hans A., Ph.D., Professor, Atmospheric Sciences
Rango, Albert, Ph.D., Assistant Professor, Meteorology

DEPARTMENT OF PHYSICS

Skudrzyk, Eugen, A.G.C.G.I., Ph.D. habil. Professor, Acoustics

To obtain further information, address all inquiries directly to:

Biology, Physics

Dean E. S. Lindstrom
Associate Dean of Science

214 Whitmore Laboratory
Pennsylvania State University
University Park, Pennsylvania 16802

Geochemistry, Geology, Meteorology

Dean E. W. Miller
Assistant Dean for Resident Instruction
101 Mineral Sciences Building
Pennsylvania State University
University Park, Pennsylvania 16802

## UNIVERSITY OF PENNSYLVANIA
### PHILADELPHIA, PENNSYLVANIA

In a recently instituted program, the Geology Department of the University of Pennsylvania offers a curriculum of emphasis in marine sciences as an option for undergraduate Geology majors. This curriculum leads to a B.A. degree in Geology.

Minimum requirements for a B.A. in Geology include Chemistry 101 and 102, Mathematics 140 and 141, Physics 150 and 151, and Eight Units of Geology. Individual programs are tailored to the aims and interests of students selecting an emphasis in Oceanography.

The following courses are offered in conjunction with the above programs:

GEOLOGY DEPARTMENT

| | |
|---|---|
| 103 | Oceanography |
| 205 | Paleontology |
| 206 | Principles of Stratigraphy |
| 401 | Environmental Geology |
| 418 | Introduction to Geochemistry |
| 505 | Advanced Paleontology Seminar |
| 518 | Geochemistry |
| 522 | Pleistocene Geology |

BIOLOGY DEPARTMENT

| | |
|---|---|
| 101 | Environmental Biology |
| 102 | Biology of Organisms |
| 411 | Evolution |
| 414 | Population and Community Ecology |
| 504 | Ecological Methods |
| 510 | Marine Life |
| 555 | Marine Ecology Field Course |

The instructional staff for the courses listed above consists of the following:

GEOLOGY DEPARTMENT

Banerjee, Subir K., Ph.D., (part-time)
Faul, Henry, Ph.D.
Friedman, Irving, Ph.D., (part-time)
Gaines, Alan M., Ph.D.
Giegengack, Robert F., Ph.D.
Harker, R. Ian, Ph.D.
Harroun, Dale T., Ph.D.
Richards, Horace G., Ph.D., (part-time)
Schnetzler, Charles C., Ph.D., (part-time)
Thoumsin, Servious F., Jr., M.S., (part-time)
Wagner, Gunther A., Ph.D.

To obtain further information, address all inquiries directly to:

Dr. Henry Faul
Chairman

Department of Geology
University of Pennsylvania
Philadelphia, Pa. 19104

## PRINCETON UNIVERSITY
### PRINCETON, NEW JERSEY

Major facilities include an IBM 360/91 computer, radio-chemistry laboratory, electron microprobe, X-ray equipment, and field recording instruments. The National Oceanographic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory is located on campus and a joint program in atmospheric sciences and physical oceanography is offered. Pronceton possesses no unique marine facility, but cooperative arrangements with other institutions are made for ship and shore facilities.

The following degrees are offered:

1. Ph.D. in Marine Geology (Department of Geological and Geophysical Sciences). All students are expected to have a broad knowledge of geology/geophysics with special emphasis on a marine topic. Topics currently pursued by the department are sea floor spreading, processes of trenches and mountain building, marine magnetics, reflection seismology, sediment deposition, evolution of ocean's chemistry, carbonate sedimentation, and invertebrate paleontology. There are no course requirements but all students must satisfactorily complete a comprehensive examination and demonstrate a capacity for independent research by completing a thesis project. A reading knowledge of two foreign languages is required

2. Ph.D. in Physical Oceanography (Geophysical Fluid Dynamics Program). Three participating departments, Aerospace and Mechanical Sciences, Civil and Geological Engineering, and Geological and Geophysical Sciences, cooperate in this joint program. Advanced study and research in the program is carried out in collaboration with the Geophysical Fluid Dynamics Laboratory of the National Oceanographic and Atmospheric Administration, which is located on campus. Research projects in the following areas are emphasized: large scale theory of circulation in atmosphere, ocean and interior of the earth, boundary layer problems, thermal convection, geophysical turbulence, transport properties, thermal budget, planetary atmospheres, and wave phenomena. Large scale computing facilities are available for the study and simulation of these problems. A plan of course work and research will be worked out by the student and his adviser. The student must have a knowledge of one foreign language, pass the General Examination (usually after two years of study), and present an acceptable dissertation.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF GEOLOGICAL AND GEOPHYSICAL SCIENCES

GRADUATE COURSES

| | |
|---|---|
| 507 | Regional Structural Geology |
| 508 | Principles of Sedimentology |
| 517 | Invertebrate Paleontology |
| 518 | Invertebrate Paleontology |
| 519 | Geology of Continental Margins |
| 523 | Geochemistry of the Atmosphere and Oceans |
| 530 | Chemical Sediments |

| | |
|---|---|
| 532 | Petrology Seminar |
| 535 | Special Topics in Geophysics |

GEOPHYSICAL FLUID DYNAMICS PROGRAM

GRADUATE COURSES

| | |
|---|---|
| 501 | Introduction to Geophysical Fluid Dynamics |
| 502 | Introduction to Geophysical Fluid Dynamics |
| 503 | Physical Oceanography |
| 504 | Dynamical Climatology |
| 505 | Dynamic Prediction |
| 506 | Special Topics in Geophysical Fluid Dynamics |

In addition, numerous courses in fluid mechanics, mathematics, and other background subjects are offered by various departments.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOLOGICAL AND GEOPHYSICAL SCIENCES

Bonini, William E., Ph.D., Professor, Geological Engineering
*Bryan, Kirk, Ph.D., Professor, Physical Oceanography
*Burk, Creighton A., Ph.D., Professor, Regional Geology
Dahlen, Anthony F., Ph.D., Assistant Professor, Geophysics
*Deffeyes, Kenneth S., Ph.D., Associate Professor, Marine Geology
Dorf, Erling, Ph.D., Professor, Paleobotany and Stratigraphy
*Fischer, Alfred G., Ph.D., Professor, Regional Geology and Invertebrate Paleontology
Hargraves, Robert B., Ph.D., Associate Professor, Petrology and Rock Magnetism
Hedberg, Hollis D., Ph.D., Professor, Stratigraphy
*Holland, Henrich D., Ph.D., Professor, Geochemistry
Hollister, Lincoln S., Ph.D., Assistant Professor, Petrology
Jepsen, Glenn L., Ph.D., Professor, Vertebrate Paleontology
Judson, Sheldon, Ph.D., Chairman and Professor, Geomorphology
*Kinsman, David J.J., Ph.D., Associate Professor, Carbonate Sedimentation
*Morgan, W. Jason, Ph.D., Assistant Professor, Marine Geophysics
*Phinney, Robert A., Professor, Geophysics
Smagorinsky, Joseph, Ph.D., Professor, Atmospheric Sciences
*Stegen, Gilbert R., Ph.D., Assistant Professor, Physical Oceanography
*Van Houten, Franklyn B., Ph.D., Professor Sedimentology
Waldbaum, David S., Ph.D., Associate Professor, Geochemistry

*Active in Marine Research

GEOPHYSICAL FLUID DYNAMICS PROGRAM

Bryan, Krik, Ph.D., Professor, Physical Oceanography
Manabe, Sykuro, Ph.D., Professor, Atmospheric Sciences
Mattingly, George E., Ph.D., Assistant Professor, Hydrodynamics
Mellor, George L., Ph.D., Director and Professor, Fluid Dynamics
Miyakada, Kikuro, Ph.D., Professor, Atmospheric Sciences
Phinney, Robert A., Ph.D., Professor, Geophysics
Smagorinsky, Joseph, Ph.D., Professor, Atmospheric Sciences
Stegen, Gilbert, Ph.D., Assistant Professor, Physical Oceanography

To obtain further information, address all inquiries directly to:

Dean of the Graduate School
Princeton University
Princeton, New Jersey 08540

## UNIVERSITY OF PUERTO RICO
### MAYAGUEZ, PUERTO RICO

The Department of Marine Sciences was established as the Institute of Marine Biology on the Mayaguez campus of the University of Puerto Rico in 1954. The main offices are located on campus. The department's marine station is 22 miles to the south on 18-acre Magueyes Island which is about 100 yards offshore from La Parguera. The island is within a broad embayment which is notable for many types of marine habitats. Buildings at the station include a staff laboratory, a museum building, an aquarium building with a large classroom, and several service buildings. In addition to skiffs, the department operates the 58-foot MEDUSA fitted with basic equipment for oceanographic and marine biological work.

The University offers the degree of M.S. in Marine Sciences.* All candidates are required to complete a minimum of 30 credit hours of graduate credit. Of these only six credits may be in courses open to advanced undergradutae as well as graduate students, and a minimum of six credits must be in related courses offered in the graduate programs of other departments. All of the candidates must demonstrate facility in Spanish and English as well as ability to read and translate in one other modern language in which there is sufficient scientific literature in their field of specialization. They must satisfactorily complete a research project, a thesis based on the project, and a comprehensive oral examination.

*A Ph.D. program is tentatively scheduled to begin in 1971.

The following courses are offered in conjunction with the above program:

ADVANCED UNDERGRADUATE/GRADUATE COURSES

| | | |
|---|---|---|
| 553 | Fisheries Biology | 3 |
| 558 | Systematics of Marine Invertebrates | 3 |
| 564 | Ichthyology I | 3 |
| 595 | Marine Ecology | 6 |

GRADUATE COURSES

| | | |
|---|---|---|
| 601 | Coastal Geomorphology | 3 |
| 605 | Geology of Deep Ocean Basins | 3 |
| 611 | Coastal Processes | 3 |
| 617 | Dynamical Oceanography I | 3 |
| 618 | Dynamical Oceanography II | 3 |
| 619 | Special Problems in Physical Oceanography | 1-3 |
| 621 | Marine Sciences | 4 |
| 622 | Marine Sciences | 4 |
| 625 | Marine Microbiology | 3 |
| 628 | Chemical Oceanography | 3 |

| | | |
|---|---|---|
| 629 | Chemical Oceanography Laboratory | 3 |
| 631 | Marine Physiology | 3 |
| 632 | Marine Physiology Laboratory | 1 or 2 |
| 635 | Marine Biogeography | 3 |
| 637 | Special Problems in Chemical Oceanography | 1-3 |
| 638 | Selected Topics in Physiological Ecology | 3 |
| 640 | Special Problems in Marine Physiology | 3 |
| 646 | Morphology of Marine Invertebrates | 3 |
| 647 | Special Problems in Marine Invertebrates | 1-3 |
| 648 | Marine Invertebrate Embryology | 3 |
| 650 | Advanced Fisheries Biology | 3 |
| 652 | Biological Oceanography | 3 |
| 653 | Special Problems in Fisheries Biology | 1-3 |
| 655 | Aquaculture | 4 |
| 656 | Special Studies in Aquaculture | 1-3 |
| 661 | Marine Botany | 3 |
| 662 | Special Problems in Marine Algae | 1-3 |
| 665 | Ichthyology II | 3 |
| 666 | Special Problems in Ichthyology | 1-3 |
| 668 | Pigment Physiology | 3 |
| 671 | Instrumental Methods in Marine Sciences | 3 |
| 681 | Ecology of Marine Communities | 2 |
| 691 | Graduate Seminar | 1 |
| 692 | Graduate Seminar | 1 |
| 695 | Special Problems | 1-3 |
| 699 | Research | Up to 6 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF MARINE SCIENCES

Almodovar, Luis R., Ph.D., Professor
Atwood, Donald K., Ph.D., Associate Professor
Burkholder, Paul H., Ph.D., Professor
Cerame-Vivas, Maximo J., Ph.D., Director and Associate Professor
Cutress, Charles E., M.S., Professor
Eger, William H., M.S., Assistant Professor
Giese, Graham S., Ph.D., Associate Professor
Gonzalez, Juan G., M.S., Assistant Professor
Maddux, William S., Ph.D., Associate Professor
Pagan-Font, Francisco A., Ph.D., Assistant Professor
Ting, Robert Y., Ph.D., Associate Professor
Tosteson, Thomas R., Ph.D., Professor
Zeigler, John M., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dr. Maximo J. Cerame-Vivas, Director
Department of Marine Sciences
University of Puerto Rico
Mayaguez, Puerto Rico 00708

## UNIVERSITY OF RHODE ISLAND
### KINGSTON, RHODE ISLAND

The Graduate School of Oceanography, maintains a group of laboratories, offices and support facilities at the Narragansett Bay Campus, a waterfront location in Naragansett, R.I. Principal structures are the Charles J. Fish Oceanographic Laboratory, the Francis H. Horn Laboratory, and the Claiborne Pell Marine Science Library, the latter two completed in 1968. The graduate school operates R/V TRIDENT, a 180-foot research vessel, and a number of small craft.

The University offers the degrees of Master of Science in Oceanography and Doctor of Philosophy in Oceanography. Both degrees are given with options in biological, chemical, geological, and physical oceanography.

The University also offers the Master of Marine Affairs (MMA). The Master of Marine Affairs Program is administratively within the Department of Geography and is supervised by an Administering Committee composed of the Provost for Marine Affairs, Dean of the Graduate School of Oceanography, Director of the Law of the Sea Institute, the Chairman or his representative of the Departments of Ocean Engineering, Resources Economics, Geography, Geology, and Political Science. Admission to the MMA Program normally requires a graduate degree and experience in marine related employment. The course of study is designed for persons interested in management and policy problems associated with marine activities.

The MMA Program is interdisciplinary; a one academic year non-thesis graduate program. All students study a core curriculum in Marine Geography, Resource Economics, Oceanography, Ocean Engineering and International Law.

Additional course work and/or supervised research in areas of the student's basic expertise is done among the graduate courses offered at the University in Oceanography, Ocean Engineering, Political Science, Geography, and Business Administration. Integration of the course work for a meaningful appreciation of elements of management and decision-making in High Seas and Coastal Zone Marine Resources is conducted in the Marine Affairs Seminar.

The following courses in the marine sciences are offered in conjunction with these programs. In addition, graduate students in oceanography may choose from supporting courses in other departments of the University.

| | | |
|---|---|---|
| 401 | General Oceanography | 3 |
| 501 | Physical Oceanography | 3 |
| 510 | Descriptive Physical Oceanography | 3 |
| 521 | Chemical Oceanography | 3 |
| 540 | Geological Oceanography | 3 |
| 561 | Biological Oceanography | 3 |
| 567 | Marine Bacteriology | 3 |
| 568 | Fishery Biology | 3 |
| 571 | Benthic Environment | 3 |
| 574 | Biology of Marine Mammals | 2 |
| 599 | Master's Research | |
| 605 | Dynamical Oceanography | 3 |
| 611 | Geophysical Hydrodynamics | 3 |
| 612 | Experimental Geophysical Hydrodynamics | 3 |
| 613 | Waves | 3 |
| 614 | Tides | 1 |
| 621 | The Estuary & Coastal Zone | 3 |

| | | |
|---|---|---|
| 623 | Physical Chemistry of Sea Water | 3 |
| 625 | Organic Chemistry | 3 |
| 630 | Geochemistry | 3 |
| 631 | Seminar in Marine Chemistry | 1 |
| 643 | Seminar in Deep Sea Geology | 3 |
| 644 | Thermodynamics of the Earth's Interior | 3 |
| 645 | Geology of Continental Margins | 3 |
| 647 | Recent Sedimentary Environments | 3 |
| 648 | Marine Paleoecology | 4 |
| 661 | Phytoplankton Taxonomy | 3 |
| 662 | Ecological Concepts in Marine Research | 3 |
| 663 | Phytoplankton Physiology | 3 |
| 664 | Phytoplankton Ecology | 4 |
| 666 | Zooplankton | 3 |
| 667 | Advanced Phytoplankton Seminar | 2 |
| 668 | Advanced Phytoplankton Seminar | 2 |
| 669 | Advanced Phytoplankton Seminar | 2 |
| 672 | Marine Invertebrates & Environments | 3 |
| 673 | Advanced Animal Behavior | 4 |
| 683 | Quantitative Genetics I | 3 |
| 684 | Quantitative Genetics II | 3 |
| 691 | Individual Study | 1-6 |
| 692 | Individual Study | 1-6 |
| 693 | Special Studies | 1-4 |
| 694 | Special Studies | 1-4 |
| 695 | Seminar in Oceanography | 1 |
| 699 | Ph.D. Thesis Research | |

MARINE AFFAIRS CORE PROGRAM

GRADUATE COURSES

| | | |
|---|---|---|
| GEG 517 | Marine Geography | 3 |
| FRE 514 | Economics of Marine Resources | 3 |
| OCE 500 | General Oceanography | 3 |
| OE 500 | Basic Ocean Engineering | 3 |
| MAF 910 | International Law of the Sea | 3 |
| MAF 650 | Marine Affairs Seminar | 6 |

The University also offers a graduate program in ocean engineering and an associate program in fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Dietz, Frank, Ph.D., Professor of Physics and Oceanography
Knauss, John A., Ph.D., Professor, Dean and Provost for Marine Affairs
McMaster, Robert L., Ph.D., Professor
Marshall, Nelson, Ph.D., Professor
Pratt, David M., Ph.D., Professor
Saila, Saul, Ph.D., Professor
Sieburth, John McN., Ph.D., Professor
Smayda, Theodore J., Dr.Philos., Professor
Sprague, Lucien, Ph.D., Professor
Stern, Melvin, Ph.D., Professor
Watkins, Norman D., Ph.D., Professor
Winn, Howard E., Ph.D., Professor
Duce, Robert A., Ph.D., Associate Professor
Jeffries, H. Perry, Ph.D., Associate Professor
Kennett, James, Ph.D., Associate Professor
Krause, Dale C., Ph.D., Associate Professor
Sastry, Akella N., Ph.D., Associate Professor
Schilling, Jean-Guy, Ph.D., Associate Professor
Sturges, Wilton, Ph.D., Associate Professor
Diamantis, Basil, Ph.D., Assistant Professor
Kenyon, Kern, Ph.D., Assistant Professor
Kester, Dana, Ph.D., Assistant Professor
Lambert, Richard, Ph.D., Assistant Professor
Napora, Theodore A., Ph.D., Assistant Professor and Assistant Dean for Students
Nixon, Scott, Ph.D., Assistant Professor
Pilson, Michael E., Ph.D., Assistant Professor
Quinn, James, Ph.D., Assistant Professor
Swift, Elijah, Ph.D., Assistant Professor
deBoer, Jelle, Ph.D., Adjunct Professor
Phelps, Donald, Ph.D.,Adjunct Professor
Shaw, David M., Ph.D., Adjunct Professor
Shuster, Carl H., Ph.D., Adjunct Professor

MASTER OF MARINE AFFAIRS PROGRAM

GRADUATE SCHOOL OF OCEANOGRAPHY

Knauss, John A., Ph.D., Provost for Marine Affairs and Dean
Marshall, Nelson, Ph.D., Professor of Oceanography

DEPARTMENT OF OCEAN ENGINEERING

Middletion, Foster H., Dr. Eng., Chairman and Professor of Ocean Engineering
Sheets, Herman E., Dr. Eng., Professor of Ocean Engineering

DEPARTMENT OF GEOGRAPHY

Alexander, Lewis M., Ph.D., Chairman and Professor of Geography
Koers, Albert W., Visiting Professor of Marine Affairs

DEPARTMENT OF RESOURCES ECONOMICS

Lampe, Harlan C., Professor of Resources Economics
Rorholm, Niels, Ph.D., Professor of Resources Economics

DEPARTMENT OF GEOLOGY

Fisher, John J., Ph.D., Assistant Professor of Geology

To obtain further information, address all inquiries directly to:

Dr. John A. Knauss, Dean, Professor and Provost for Marine Affairs

Dr. Theodore A. Napora, Assistant Professor and Assistant Dean for Students
University of Rhode Island
Kingston, Rhode Island 02881

Dr. Lewis M. Alexander
Director of Marine Affairs Program
225 Washburn Hall
University of Rhode Island
Kingston, Rhode Island 02881

## RICE UNIVERSITY
HOUSTON, TEXAS

Rice's current activity in the rapidly growing field of marine science is based on a continuing study of the marine environment and the geological processes affecting the shore, shelf, and continental slope of the Gulf of Mexico. Studies include a general investigation of the continental shelf and shoreline sediments, and the biological components of the sediment. The marine geophysics program is concerned with the properties of the crust in the Gulf and Caribbean regions. The geological processes of the formation of adjacent land masses are also studied and compared to the modern processes.

The Department of Geology is equipped with laboratory facilities and oceanographic instrumentation for marine geology and geophysical measurements. This includes a seismic profiling system with air gun, sparker and crystal sound sources; thermoprobes; a proton magnetometer and various bottom sampling devices. The Department of Geology owns a cabin cruiser used for estuarine, shallow continental shelf work and instrument testing. Ship time is customarily available on a variety of research vessels. Cooperative projects are in progress with government agencies and universities in the United States and Mexico.

The Department of Geology has graduate studies in geology, geophysics, and geochemistry leading to the degrees of Master of Arts and Doctor of Philosophy. There is no single prescribed curriculum for all graduate students. Course programs are developed in line with a student's needs, interests, and aims. Graduate work in geology is oriented toward the theoretical and fundamental aspects of the subject rather than directly toward its many applied aspects. All geology students are expected to have strong backgrounds in mathematics, physics, and chemistry.

Graduate students at Rice may work on established projects or initiate their own if they are compatible with the equipment available and the interests of the staff. Approximately one-quarter of the thesis work in the department is related to oceanography.

Candidates for advanced degrees in geology are expected to:

1. Pass a reading exam in one foreign language for the master's (usually German) and in two foreign languages for the doctorate (usually German and French or Russian). Options for the doctorate include the substitution of an approved program in a field outside the Department for one language or a comprehensive knowledge of one language instead of a reading knowledge of two.
2. Complete at a high level an approved program in geology and related subjects.
3. Pass during first year of residence a basic examination in geology. At a later date a Ph.D. qualifying examination is required of all doctoral candidates. This is administered by the thesis committee.
4. Complete for publication a thesis which represents an original contribution to the science.
5. Defend orally the research work and conclusions of the thesis.
6. Engage in some laboratory instruction, regardless of type of appointment.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| Geo 331b | Sedimentation | 4 |
| Geo 400a | Invertebrate Paleontology | 4 |
| Geo 401b | Stratigraphy and Advanced Historical Geology | 4 |
| Geo 418a | Marine Geology | 4 |
| Geo 440a | Introduction to Geophysics | 4 |

In addition, research seminars are conducted in several aspects of oceanography and related topics.

The instructional staff for the courses listed above consists of the following:

Clark, H.C., Ph.D.
Lankford, Robert R., Ph.D.
Warme, John E., Ph.D.
Wilson, James Lee, Ph.D.

To obtain further information, address all inquiries directly to:

Dr. James L. Wilson, Graduate Advisor
Department of Geology
Rice University
Houston, Texas 77001

## RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
NEW BRUNSWICK, NEW JERSEY
CAMDEN, NEW JERSEY
NEWARK, NEW JERSEY

Modern laboratory facilities in the basic sciences are available on the three city campuses listed above. In addition, the University operates three small laboratories on the New Jersey coast, all involved with various aspects of shellfish research. A 40-foot research vessel, based at one of these laboratories on Delaware Bay, operates year-round, providing facilities for power dredging, hydrographic sampling, etc. within the estuary. A small fleet of outboards is available for a variety of studies in the coastal bays and sounds, throughout the length of the State. An ancient houseboat laboratory is another base for summer work in one of the estuaries. The research programs underway in these laboratories provide coastal marine experiences for approximately 20 students annually.

Undergraduate students planning to do advanced work in the marine sciences usually major in one of several undergraduate degree programs such as Biology, Geology, Environmental Science, Chemistry, etc. In addition to satisfying requirements for their major, these students may elect one or more undergraduate courses from the list below.

At the graduate level no degree program is specifically labelled "marine", but graduate students in Ph.D. programs in Zoology, in Botany, in Environmental Science, in Ecology, in Microbiology, in Geology, etc. can gain marine experience in the coastal research programs underway here.

A new Ph.D. program in Geophysical Fluid Dynamics is now offered through the cooperative efforts of the Department of Mechanical and Aerospace Engineering and the Department of Meteorology. Teaching and research concentrate on fluid dynamics problems of the geosphere, i.e., on meteorological and oceanographic fluid dynamics and related problems. The program draws on research and graduate courses in the fields of meteorology, engineering, mathematics, information sciences and others as necessary. Speciali-

zations available within the program include meteorology, oceanography, upper atmosphere dynamics, air pollution, turbulence, turbulent dispersion and rotating and stratified flow.

Students select from courses in meteorology, mechanical and aerospace engineering and related graduate programs such as Computer Sciences, Mathematics and Statistics. Particularly relevant are Meteorology 501 and 508; Mechanical Engineering 515-16; 517-18; 621; 622; Geophysical Fluid Dynamics 501 and 611.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

BIOLOGICAL SCIENCES DEPARTMENTS

| | |
|---|---|
| 12-120-415 | Marine Ecology |
| 12-990-406 | Limnology |
| 93-375-403 | Air and Water Environment |
| 93-375-404 | Aquatic Biology |
| 93-375-444 | Water Resources |
| 12-130-411 | Algae: Morphology and Taxonomy |
| 21-990-415 | Marine Biology (Newark) |
| 02-120-212 | The Ecology of Marine Animals |

DEPARTMENT OF GEOLOGY

| | |
|---|---|
| 12-460-451 | Geology of Ocean Basins |
| 12-460-453 | Paleoecology |
| 21-460-331 | Oceanology (Newark) |

DEPARTMENT OF METEOROLOGY

| | |
|---|---|
| 93-670-301 | Elements of Meteorology |
| 93-670-421 | Dynamic Meteorology |
| 93-670-422 | Dynamic Meteorology |
| 93-670-417 | Synoptic Meteorology |
| 93-670-418 | Synoptic Meteorology |
| 93-670-432 | Physical Oceanography |

GRADUATE COURSES

BIOLOGICAL SCIENCES DEPARTMENTS

| | |
|---|---|
| 130-513 | The Algae: Biology and Physiology |
| 375-503 | Environmental Chemistry and Analysis |
| 375-511 | Ichthyology |
| 375-512 | Ichthyology and Fishery Management |
| 990-504 | Elements of Oceanography |
| 990-505 | Malacology |
| 990-506 | Ecology of the Estuary |

DEPARTMENT OF GEOLOGY

| | |
|---|---|
| 460-526 | Planktonic Foraminifera |
| 460-553 | Micropaleontology: Foraminifera |
| 460-554 | Micropaleontology: Foraminifera |
| 460-570 | Marine Geology |

GEOPHYSICAL FLUID DYNAMICS

| | |
|---|---|
| 465-501 | Fluid Dynamics of the Atmosphere |
| 465-611 | Seminar in Geophysical Fluid Dynamics |

DEPARTMENT OF METEOROLOGY

| | |
|---|---|
| 670-501 | Micrometeorology |
| 670-508 | Dynamic Climatology |

The University also offers undergraduate and graduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following members. Staff members listed below are on the New Brunswick area campus unless otherwise indicated as at Camden or Newark.

BIOLOGICAL SCIENCES DEPARTMENTS

Bartha, Richard, Ph.D., Associate Research Professor of Biochemistry and Microbiology
Buell, Murray F., Ph.D., Professor of Botany
Durand, James B., Ph.D., Professor of Zoology (Camden)
Gardiner, Lion
Good, Ralph, Ph.D., Assistant Professor of Botany (Camden)
Hansens, Elton, Ph.D., Professor of Entomology
Haskin, Harold H., Ph.D., Professor of Zoology and Shellfish Investigations
Jenkins, W. Robert, Ph.D., Professor of Biology
Jobbins, Daniel M., M.S., Professor of Entomology
Lechevalier, Hubert A., Ph.D., Professor of Microbiology
Litchfield, Carter, Ph.D., Associate Professor of Biochemistry
Loveland, Robert E., Ph.D., Associate Professor of Zoology
McDowell, Samuel D., Ph.D., Professor of Zoological Sciences (Newark)
Moul, Edwin T., Ph.D., Professor of Botany
Pearce, John B., Ph.D., Associate Professor of Biology
Pramer, David, Ph.D., Professor of Biochemistry and Microbiology
Raschke, Ronald L., Ph.D., Assistant Professor of Botany
Stauber, Leslie A., Ph.D., Professor of Zoology
Trama, Francesco B., Ph.D., Associate Professor of Zoology
Weiss, Judith S., Ph.D., Assistant Professor of Zoology and Physiology (Newark)

DEPARTMENT OF ENVIRONMENTAL SCIENCE

Faust, Samuel D., Ph.D., Professor of Environmental Science
Hunter, Joseph V., Ph.D., Professor of Environmental Science
Kaplovsky, A. Joel, Ph.D., Professor of Environmental Science
Westman, James R., Ph.D., Professor of Environmental Science

DEPARTMENT OF GEOLOGY

Fox, Steven K., Ph.D., Professor of Geology
Hirsch, Alfred M., Ph.D., Assistant Professor of Geology (Camden)
Murray, Raymond C., Ph.D., Professor of Geology
Olsson, Richard K., Ph.D., Associate Professor of Geology
Psuty, Norbert P., Ph.D., Associate Professor of Geology
Saito, Tsuenmasa, Ph.D., Adjunct Associate Professor of Geology (Newark)



445-776 O - 71 - 7

Wiles, William W., Ph.D., Associate Professor of Geology

DEPARTMENT OF METEOROLOGY

Binkowski, Francis S., M.S., Assistant Professor of Meteorology
Havens, A. Vaughan, M.S., Professor of Meteorology
Pell, Jerry, Ph.D., Assistant Professor of Meteorology
Shulman, Mark D., Ph.D., Associate Professor of Meteorology

To obtain further information, address all inquiries directly to:

Dr. Harold H. Haskin
Department of Zoology
Rutgers University
New Brunswick, New Jersey 08903

## SACRAMENTO STATE COLLEGE
### SACRAMENTO, CALIFORNIA

The college offers marine science courses on the Sacramento campus in the Departments of Biological Sciences and Physics-Physical Sciences (as part of the curricula in environmental biology and geology, respectively). The college also participates in the operation of the Moss Landing Marine Laboratories in Moss Landing, California (on Monterey Bay), as a part of a consortium of five California State Colleges described in the Consortia section. The science departments at the college occupy a five-story building completed in 1967; the Biological Sciences Department occupies approximately one-and-one-half floors of space in this large building, as well as retaining the two-story building occupied earlier; these aggregate about 69,000 square feet of floor space, 45,000 in the larger building and 24,000 in the smaller. The Physics-Physical Sciences Department takes up approximately one-and-a-half stories of space. Laboratories are modern and functional. The Biological Sciences Department maintains a 23-foot research inboard power cruiser and several smaller boats and the science building has salt water facilities. The Sacramento campus is located within an hour's drive of estuarine environments and within two hour's drive of the Pacific Ocean.

The following degrees are offered:

1. B.A. in Biological Sciences. A broad based, normal 124 semester-unit baccalaureate degree. Chemistry, physics, mathematics, and statistics are required as supporting subjects. For the marine sciences specialty Bio. Sci. 150, 162. 163 and Geology 101 are specified and Bio. Sci. 173 is recommended.

2. B.S. in Biological Sciences (Biological Conservation (Fish and Game)). This is a 132 semester-unit degree, which consists of the basic biology curriculum, with the addition of certain fish and game and other conservation courses.

3. M.A. in Biological Sciences. Students take several required courses in biological sciences, as well as supporting courses. A thesis is required. Certain courses and the thesis research can be done at Moss Landing Marine Laboratories.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences

| | | |
|---|---|---|
| 162 | Ichthyology | 3 |
| 163 | Marine Ecology | 3 |
| 173 | Principles of Fisheries Biology | 3 |
| 273 | Advanced Fishery Biology | 3 |
| 196 | Proseminar | 2 |
| 296 | Seminar | 2 |
| 199 | Special Problems | 2 |
| 299 | Special Problems | 2 |
| 500 | Master's Thesis | 2-4 |

Department of Physics-Physical Sciences: (Department of Geology)

| | | |
|---|---|---|
| 101A | General Oceanography | 3 |
| 101B | Marine Geology | 3 |
| 196 | Seminar | 1-4 |
| 199 | Special Problems | 1-3 |

Moss Landing Marine Laboratories offers approximately a dozen courses in this field, as well as seminars, workshops, and research.

The instructional staff for the courses listed above consists of the following:

Department of Biological Sciences

Brittan, Martin R., Ph.D., Professor of Biological Sciences
Meeker, Gary L., Ph.D., Assistant Professor of Biological Sciences
Schinske, Robert, M.S., Associate Professor of Biological Sciences
Vanicek, C. David, Ph.D., Assistant Professor of Biological Sciences

Department of Physics-Physical Sciences

Janke, Norman C., Ph.D., Professor of Geology
McGeary, David F. R., Assistant Professor of Geology

To obtain further information, address all inquiries directly to:

Chairman
Department of Biological Sciences
Sacramento State College
Sacramento, California 95819

## SALEM STATE COLLEGE
### SALEM, MASSACHUSETTS

Present facilities at Salem include classroom and laboratory facilities in the Arts and Sciences Building on campus. Five different marine environments lie within five minutes walk of the campus.

No degrees are specifically offered in the marine sciences. Students in the Liberal Arts Program may major in biology or geology and select among the following marine science courses:

| | | |
|---|---|---|
| BI 320 | General Ecology | 4 |
| BI 322 | Oceanology | 4 |
| BI 317 | Marine Botany | 4 |
| BI 318 | Marine Ecology | 4 |
| GE 231 | Introduction to Oceanography | 4 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Moore, Johnes K., Ph.D., Associate Professor of Biology

Paine, Claire M., Ph.D., Associate Professor of Biology
Schooley, James B., Ph.D., Professor of Biology
Sweeney, Edward F., M.S., Associate Professor of Biology
Sullivan, Frank L., M.A., Associate Professor of Biology
Terrell, Charles R., M.S., Instructor

DEPARTMENT OF GEOGRAPHY

Centorino, James J., A.M., Associate Professor of Geography

To obtain further information, address all inquiries directly to:

Dr. Johnes K. Moore
Department of Biology
Salem State College
Salem, Massachusetts 01970

## SAN DIEGO STATE COLLEGE
### SAN DIEGO, CALIFORNIA

Marine sciences courses and research programs are conducted primarily at the main campus, located 10 miles from the coast. Active course and research programs in the marine sciences are coordinated by an interdisciplinary Bureau of Marine Sciences. All participating departments have modern, well-equipped classroom, laboratory and shop facilities. Provisions for marine-related instruction and research include standard physical and biological oceanographic equipment, laboratories for the analysis of sea water and sediment characteristics, radioisotope and electron microscope facilities, computer facilities, constant temperature rooms and closed-system seawater aquaria. Library holdings are well-represented in the marine sciences and are housed in a new library building completed December 1970. The extensive marine sciences libraries of Scripps Institution of Oceanography and the National Marine Fisheries Service Fishery-Oceanography Center at La Jolla are readily accessible. Small boat docking facilities are maintained on Mission Bay, and by co-operative agreement with Scripps Institution of Oceanography, San Diego State has access to the Nimitz Marine Facility at Point Loma, California. Several small craft, one equipped with a fathometer and hydrographic winch, are available for coastal sampling operations. The use of larger oceanographic vessels and other specialized laboratory facilities are arranged in cooperation with the Scripps Institution of Oceanography and the Fishery-Oceanography Center of the National Marine Fisheries Service. Aqua-culture research facilities are being developed at the San Diego Gas and Electric Company's steam electric generating plant located on South San Diego Bay near Chula Vista, California.

The following degrees are offered:

1. A.B. in Geography, A.B. and B.S. in Biology, Botany, Chemistry, Geology, Physics, and Zoology; B.S. in Engineering. All students are required to fulfill the general education requirements of the college and to complete a series of core courses in their major field and in related areas of science and mathematics. Students are encouraged to obtain practical research experience through senior investigation and special studies courses.

2. M.A. in Physical Science; M.A. and M.S. in Biology, Chemistry, and Physics; M.S. in Geology and Engineering. All students are required to obtain research experience and to demonstrate competence in their major field by satisfactorily completing a comprehensive examination and a thesis project. In order to qualify for the degree, the student must have a 3.0 grade point average in all undergraduate work taken for the baccalaureate degree and satisfy the requirements of the department from which the degree will be granted.

3. Ph.D. in Chemistry, Ecology, and Genetics, offered jointly with the University of California. In order to qualify for this program, the student must be admitted to regular graduate standing by the University of California and San Diego State College. He must be prepared to take orientation examinations covering the specific fields in each discipline that are administered by a joint guidance committee. After formal admission to the program, the student must spend at least one year in full-time residence on each of the two campuses. A dissertation on a subject chosen by the student related to his field of specialization, demonstrating his ability to conduct independent research is required of all candidates. A reading knowledge of two foreign languages is required. A joint doctoral committee, consisting of three faculty members from each institution, conducts the qualifying and final oral examinations and guides the thesis research. The degree is awarded jointly by the participating institutions.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

COLLEGE OF SCIENCES

| | | |
|---|---|---|
| 99 | Experimental Topics: Environment | 3 |
| 100 | The Oceans | 2 |
| 196 | Undergraduate Training in Marine Technology | 6 |

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 109 | Regional Field Biology | 3 |
| 110 | Ecology | 4 |
| 111 | Aquatic Biology | 3 |
| 112 | Fisheries Biology | 3 |
| 113 | Biological Oceanography | 4 |
| 114 | Advanced Ecology | 3 |
| 175 | Statistical Methods in Biology | 3 |
| 191 | Senior Investigation and Report in Ecology | 2 |

DEPARTMENT OF BOTANY

| | | |
|---|---|---|
| 101 | Phycology | 4 |

DEPARTMENT OF CHEMISTRY

| | | |
|---|---|---|
| 180 | Chemical Oceanography | 3 |

DEPARTMENT OF ENGINEERING

| | | |
|---|---|---|
| 115 | Fluid Mechanics | 3 |
| 115L | Fluid Mechanics Laboratory | 1 |
| 123 | Applied Hydraulics | 3 |

| | | |
|---|---|---|
| 125 | Sanitary Engineering | 3 |
| 181 | Hydrodynamics | 3 |

DEPARTMENT OF GEOGRAPHY

| | | |
|---|---|---|
| 100A | Physical Climatology | 3 |
| 100B | Regional Climatology | 3 |
| 103 | Fluvial and Eolian Physiography | 3 |
| 104 | Coastal and Submarine Physiography | 3 |
| 170 | Conservation of Environmental Quality | 3 |
| 171 | Conservation of Natural Resources | 3 |
| 176 | Geography of Marine Resources | 3 |
| 187 | Remote Sensing of the Environment | 3 |
| 188 | Advanced Remote Sensing of the Environment | 3 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 106 | Paleontology | 4 |
| 107 | Principles of Stratigraphy | 3 |
| 116 | Micropaleontology | 3 |
| 126 | Sedimentology | 3 |
| 130 | Geochemistry | 3 |
| 140 | Marine Geology | 3 |
| 173 | Stratigraphic Palynology | 3 |

DEPARTMENT OF MICROBIOLOGY

| | | |
|---|---|---|
| 116 | Marine Microbiology | 4 |

DEPARTMENT OF PHYSICAL SCIENCE

| | | |
|---|---|---|
| 110 | Physical Oceanography | 3 |

DEPARTMENT OF PHYSICS

| | | |
|---|---|---|
| 114 | Acoustics | 3 |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| 105 | Invertebrate Embryology | 3 |
| 112 | Marine Vertebrate Zoology | 4 |
| 115 | Ichthyology | 4 |
| 150 | Marine Biology | 3 |
| 170 | Animal Behavior | 3 |

All above departments offer courses in senior investigation and/or research and special studies (Courses Nos. 190-199). Students can obtain practical research experience by registering in the suitable courses offered in their respective departments.

GRADUATE COURSES

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 241 | Seminar in Aquatic Ecology | 2 |
| 242 | Population and Community Ecology | 3 |
| 244 | Physical Aspects of Ecology | 3 |
| 245 | Aquatic Ecology | 3 |
| 246 | Behavioral Ecology | |

DEPARTMENT OF BOTANY

| | | |
|---|---|---|
| 200 | Seminar | 2-3 |

DEPARTMENT OF CHEMISTRY

| | | |
|---|---|---|
| 260 | Advanced Topics in Biochemistry: Photosynthesis | 2 |

DEPARTMENT OF ENGINEERING
(Graduate Courses in Civil Engineering)

| | | |
|---|---|---|
| 235 | Water Quality Engineering | 3 |
| 236 | Water Quality Processes I | 3 |
| 237 | Water Quality Processes II | 3 |
| 240 | Advanced Soil Mechanics | 3 |
| 241 | Advanced Foundation Engineering | 3 |
| 282 | Seminar in Soil Mechanics and Foundation Engineering | 2-3 |
| 283 | Seminar in Hydraulic Engineering | 2-3 |
| 284 | Seminar in Sanitary Engineering | 2-3 |

DEPARTMENT OF GEOGRAPHY

| | | |
|---|---|---|
| 200A | Seminar in Advanced Physical Climatology | 3 |
| 200B | Seminar in Advanced Regional Climatology | 3 |
| 270 | Seminar in Theory of Resource Use | 3 |
| 272 | Seminar in Environmental Quality | 3 |
| 288 | Seminar in Remote Sensing of the Environment | 3 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 212 | Sedimentary Petrology | 3 |
| 220 | Biostratigraphy | 3 |
| 221 | Advanced Palynology | 3 |
| 225 | Paleoecology | 3 |
| 229 | Seminar in Advanced Studies in Stratigraphy | 3 |
| 235 | Marine Processes | 3 |
| 280 | Sedimentary Geochemistry | 3 |

DEPARTMENT OF MICROBIOLOGY

| | | |
|---|---|---|
| 200 | Seminar | 2-3 |

DEPARTMENT OF PHYSICAL SCIENCE

| | | |
|---|---|---|
| 200 | Seminar | 2-3 |

DEPARTMENT OF PHYSICS

| | | |
|---|---|---|
| 200 | Seminar | 2-3 |
| 214 | Advanced Acoustics | 2 |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| 200 | Seminar | 2-3 |
| 201 | Seminar in Marine Zoology | 2 |
| 206 | Seminar in the Biology of Cold-blooded Vertebrates | 2 |
| 212 | Advanced Marine Invertebrate Zoology | 3 |

All above departments offer Research (297), Special Study (298) and Thesis (299); by registering in these courses the student can obtain practical research experience leading to a degree in an area of special interest.

The instructional staff of the courses listed above consists of the following:

COLLEGE OF ARTS AND LETTERS

Eidemiller, Donald I., Ph.D., Professor of Geography
Finch, William A., Jr., Ph.D., Professor of Geography

Keen, Elmer A., Ph.D., Professor of Geography
vanBeek, Johannes L., Ph.D., Assistant Professor of Geography

COLLEGE OF SCIENCES

Atkins, Michael D., Ph.D., Associate Professor of Zoology
Bennett, Larry, Ph.D., Associate Professor of Chemistry
Berry, Richard W., Ph.D., Professor of Geology
Brookes, John A., Ph.D., Associate Professor of Biology
Chen, Lo-Chai, Ph.D., Assistant Professor of Zoology
Clark, Mary E., Ph.D., Associate Professor of Biology
Dexter, Deborah M., Ph.D., Associate Professor of Zoology
Dill, Robert F., Ph.D., Assistant Professor of Geology
Ebert, Thomas A., Ph.D., Assistant Professor of Biology
Farris, David A., Ph.D., Professor of Biology
Flittner, Glenn A., Ph.D., Professor of Biology
Frederiksen, Norman O., Ph.D., Associate Professor of Geology
Ford, Richard F., Ph.D., Professor of Biology
Gallup, Avery H., Professor of Botany
Gastil, R. Gordon, Ph.D., Professor of Geology
Hazen, William E., Ph.D., Professor of Biology
Huffman, Edward W., Ph.D., Professor of Zoology
Hunsaker, Don II, Ph.D., Professor of Zoology
Ingmanson, Dale E., Ed.D., Assistant Professor of Physical Science
Jackson, Crawford G., Jr., Ph.D., Assistant Professor of Zoology
Jokela, Alice T., Ph.D., Assistant Professor of Microbiology
Kern, J. Philip, Ph.D., Assistant Professor of Geology
Krekorian, Charles O., Ph.D., Assistant Professor of Zoology
Krummenacher, Daniel, Ph.D., Associate Professor of Geology
Mathewson, James H., Ph.D., Associate Professor of Chemistry
McBlair, William, Ph.D., Professor of Biology
McEuen, Robert B., Ph.D., Associate Professor of Geology
McLean, Norman, Jr., Ph.D., Associate Professor of Zoology
Miller, Philip C., Ph.D., Professor of Biology
Moe, Chesney, Ph.D., Professor of Physics
Neel, James W., Ph.D., Professor of Biology
Olson, Albert C., Jr., Ph.D., Professor of Zoology
Phillips, Richard P., Ph.D., Associate Professor of Geology
Phleger, Charles, M.A., Instructor in Physical Science
Riffenburgh, Robert H., Ph.D., Professor of Physical Science
Schumann, George O., Ph.D., Professor of Biology
Sloan, William E., Ph.D., Professor of Biology
Snodgrass, Herschel, Ph.D., Professor of Physics
Wilson, Wilfred J., Ph.D., Professor of Zoology
Zedler, Joy, Ph.D., Assistant Professor of Biology
Zedler, Paul H., Ph.D., Assistant Professor of Biology

SCHOOL OF ENGINEERING

Chang, Hai-Yain, Ph.D., Associate Professor of Aerospace Engineering
Crooker, Andrew J., Ph.D., Assistant Professor of Aerospace Engineering
Dharmarajan, Sangiah, Ph.D., Professor of Aerospace Engineering
Eggleston, David M., Ph.D., Associate Professor of Aerospace Engineering
McGhie, Robert D., Ph.D., Associate Professor of Aerospace Engineering
Narang, Balbir S., Ph.D., Associate Professor of Aerospace Engineering
Noorany, Iraj, Ph.D., Professor of Civil Engineering
Stratton, Frank E., Ph.D., Associate Professor of Civil Engineering
Wagstaff, Ronald A. ,Ph.D., Assistant Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Director, Bureau of Marine Sciences
San Diego State College
San Diego, California 92115

## SAN FRANCISCO STATE COLLEGE
SAN FRANCISCO, CALIFORNIA

Classroom and laboratory facilities are available at the main campus in San Francisco for studies in invertebrate and vertebrate zoology,marine botany, and marine microbiology. There are also facilities for graduate studies in ecology, functional morphology, systematics, physiology, and ethology. The College enjoys a close working relationship with the nearby California Academy of Sciences where qualified students may take advantage of the valuable library and the large collections of fishes, invertebrates, and other materials for studies in systematics and morphology. San Francisco State College, in cooperation with four other California State Colleges, operates Moss Landing Marine Laboratory as a sea-side campus extension (for a detailed description of the Moss Landing facilities, refer to the Consortia section).

M.A. in Biology with a concentration in Marine Biology is offered through the Department of Marine Biology. Each student is required to complete a total of 30 semester units, selected with the approval of a marine biology advisor. Courses are to consist of upper division and graduate courses with a minimum of 15 units of graduate courses. At least one course must be taken at an approved marine station. Of graduate courses, at least two must be seminar courses. A minimum of three (maximum of six) units of research courses is required. A thesis is required (an oral or written examination may be substituted in exceptional cases) for which a student may take a maximum of six thesis research units.

The following courses are offered in conjuction with the above program:

GRADUATE COURSES

DEPARTMENT OF MARINE BIOLOGY

| | | |
|---|---|---|
| Bio 305 | Marine Animals and Plants of the California Coast | 3 |
| Bio 306 | Introduction to Marine Biology | 3 |
| Bio 486 | Marine Zoogeography | 2 |
| Bio 502 | Algology | 4 |
| Bio 555 | Marine Invertebrate Zoology | 4 |
| Bio 556 | Natural History of Marine Invertebrates | 4 |
| Bio 560 | Marine Invertebrate Physiology | 4 |
| Bio 571 | Introductory Ichthyology | 4 |
| Bio 575 | Introductory Fishery Biology | 3 |
| Bio 582 | Biological Oceanography | 3 |
| Bio 585 | Marine Ecology | 4 |
| Bio 591 | Marine Science Diver Training | 2 |
| Bio 752 | Marine Microbiology | 5 |
| Bio 786 | Advanced Morphology and Ultrastructure of Marine Invertebrates | 4 |
| Bio 790 | Systematic Ichthyology | 4 |
| Bio 793 | Plankton | 3 |
| Bio 797 | Growth and Development of Marine Algae | 3 |
| Bio 820 | Ecology of Estuaries and Lagoons | 3 |
| Bio 883 | Seminar: Marine Biology | 1 |
| Bio 893 | Advances in Marine Biology | 2 |
| Bio 897 | Research | 1-3 |
| Bio 898 | Research for Master's Thesis | 1-4 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| Geo 466 | Oceanology | 3 |
| Geo 467 | Marine Geology | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF MARINE BIOLOGY

Araki, George S., Ph.D., Associate Professor of Biology
Beeman, Robert D., Ph.D., Associate Professor of Biology
Berrend, Robert E., Ph.D., Associate Professor of Biology
Bradbury, Margaret G., Ph.D., Chairman and Associate Professor of Biology
Bowen, Sarane T., Ph.D., Associate Professor of Biology
Gustafson, Joel F., Ph.D., Professor of Biology
Hensill, John S., Ph.D., Professor of Biology and Dean of the School of Natural Sciences
Herald, Earl S., Ph.D., Lecturer in Biology
Newcombe, Curtis L., Ph.D., Professor of Biology
Oberlander, George T., Ph.D., Professor of Biology
Swan, Lawernce W., Ph.D., Professor of Biology
Tomlinson, Jack T., Ph.D., Professor of Biology
Towle, Albert, Ph.D., Professor of Biology
Treichel, Georg, B.A., Lecturer in Human Ecology
Zullo, Victor A., Ph.D., Lecturer in Biology

DEPARTMENT OF MICROBIOLOGY

Yonenaka, Hideo H., Ph.D., Associate Professor of Biology

DEPARTMENT OF GEOLOGY

Galehouse, Jon S., Ph.D., Associate Professor of Geology

To obtain further information, address all inquiries directly to:

Chairman, Department of Marine Biology
San Francisco State College
1600 Holloway Avenue
San Francisco, California 94132

## SAN JOSE STATE COLLEGE
### SAN JOSE, CALIFORNIA

Classes are conducted both on the main campus in San Jose and at the seashore station, The Moss Landing Marine Laboratories (a description of the Moss Landing facilities can be found in the Consortia section). A science building housing the geology, meteorology, chemistry and physical science departments was completed in 1967. Facilities on the geology floors include two geophysics laboratories, one sedimentation and one micropaleontology laboratory. Mineralogy laboratory and equipment are also at the disposal of students both for research and teaching purposes. A new science building for biological sciences will be completed in 1970. A separate map room with complete coverage of the ocean floor and a collection room for samples and cores for study of ocean floor sediments are also part of the facility. The computing center has also been under continuous expansion; a new Control Data 3300 computer has been installed and will boost the computing facilities which are available both for faculty and student research.

The following degrees are offered in the areas indicated:

1. Bachelor of Science with option in in Oceanography.
2. Bachelor of Arts in Biological Sciences with concentration in Marine Biology.
3. Master of Science (thesis required).

Students may specialize in any of the following fields: Geophysics, Geochemistry, Geological, Chemical or Biological Oceanography.

An interdisciplinary approach to oceanography is emphasized in the undergraduate and graduate training programs. At the undergraduate level, training is done through oceanography options for each regular science major, e.g., chemistry, geology, biology, etc. At the graduate level, training is tailored to the student for the Master's Degree; theses are required.

The following courses are offered in conjunction with the above programs (all specialized courses are upper division and graduate courses):

| | | |
|---|---|---|
| Geo 139 | General Oceanography | 4 |
| Geo 117 | Geophysics I | 3 |
| Geo 118 | Geophysics II | 3 |
| Geo 115 | Geochemistry | 3 |
| Geo 113 | Micropaleontology | 3 |
| Geo 141 | Geological Oceanography | 4 |
| Geo 142 | Marine Biogenic Sediments | 3 |
| Geo 143 | The Margin of the Oceans | 2 |
| Geo 196 | Marine Science Techniques | 1 |
| Bio 141 | Biological Oceanography | 3 |

| | | |
|---|---|---|
| Zoo 115 | Invertebrate Zoology and Natural History | |
| Zoo 176 | Advanced Invertebrates | |
| Chem 141 | Chemical Oceanography | 3 |
| Phys 141 | Physical Oceanography | 3 |
| Meteo 135 | Meteorology of the Oceans | 3 |

The instructional staff for the courses listed above consists of the following:

BIOLOGY DEPARTMENT

Ackermann, John M., M.A., Assistant Professor, invertebrate zoology
Heath, James P., Ph.D., Professor, oceanography
Kenk, Vida C., Ph.D., Associate Professor, invertebrate zoology

CHEMISTRY DEPARTMENT

Stump, Arthur, Ph.D., Assistant Professor of Chemical Oceanography

GEOLOGY DEPARTMENT

Arnal, Robert E., Ph.D., Professor of Geology
Broenkow, William W., Ph.D., Assistant Professor of Chemical and Physical Oceanography
Brooke, John P., Ph.D., Assistant Professor of Geophysics
Dillon, William P., Ph.D., Assistant Professor of Marine Geology and Geophysics
Dolloff, Norman H., Ph.D., Professor of Geology
Stevens, Calvin H., Ph.D., Associate Professor of Geology

METEOROLOGY DEPARTMENT

Miller, Albert, Ph.D., Professor of Meteorology
Read, Robert, M.S., Associate Professor of Marine Meteorology

To obtain further information, address all inquiries directly to:

Dr. Robert E. Arnal
Geology Department
San Jose State College
San Jose, California 95114

Mr. Joseph H. Young
Department of Biological Sciences
San Jose State College
San Jose, California 95114

## SCRIPPS INSTITUTION OF OCEANOGRAPHY
## UNIVERSITY OF CALIFORNIA, SAN DIEGO
### LA JOLLA, CALIFORNIA

Since 1912 the Scripps Institution of Oceanography has been a unit of the University of California. Now part of the University of California San Diego campus, the nine buildings of the Scripps Institution are clustered on the ocean shore north of the center of La Jolla, a suburb of San Diego. The SIO Library, a unit of the University Library, contains more than 70,000 volumes, 87,000 reports and reprints, 3,000 serials, and a large collection of charts. Special facilities are as follows: Radio station WWD, operated by the U.S. Bureau of Commercial Fisheries; the Scripps Pier, 1,000 feet long, housing apparatus for a number of serial oceanographic observations, and used as a landing place for skiffs: the salt water system providing clean sea water to the aquarium and biological laboratories; an underwater area for research and collecting offshore from the Institution; deep-sea sediment cores from several thousand widely scattered localities in the world ocean; original echograms along several hundred thousand miles of ships' tracks in the Pacific; Carbon-14 and tritium laboratories; an oceanographic data archive of some half a million bathythermograph (BT) observations; an electron microprobe laboratory: six mass spectrographs; several thousand samples of sea water from the world oceans; an electron microscope laboratory: the Scripps fish collection of more than 750,000 specimens of some 2,000 species of marine fish: oceanic samples of plankton. Scripps scientists have access to the University's computer center. The Institution operates seven ships specially fitted for oceanographic research: ALEXANDER AGASSIZ, FLIP (Stable research platform), ALPHA HELIX, OCONOSTOTA, E. R. SCRIPPS, WASHINGTON, MELVILLE.

Scripps offers the degree of Ph.D. in Oceanography, Ph.D. in Marine Biology, and Ph.D. in Earth Sciences. The program of study for the Ph.D. degree is determined in consultation with the student's adviser. The Department has no formal language requirements. Students are expected to have satisfied the entrance requirement of preparation in at least one important language. Within the Department, curricular programs may require demonstration of ability to use certain foreign languages pertinent to a student's research. All students are normally required to take a departmental examination, and the student will be required to demonstrate his comprehension of required subject material and of the pertinent interactions of physical, chemical, biological and geological factors. After the student has passed the departmental examination, and has completed an appropriate period of additional study the Department will recommend appointment of a doctoral committee. This committee will determine the student's qualifications for independent research by means of a Qualifying Examination and will supervise the student's performance and reporting of his research. A requirement for the Ph.D. degree is the submission of a dissertation and a final examination in which the thesis is publicly defended.

The Department does not encourage students who wish to proceed only to the M.S. degree. If circumstances warrant, the degree is normally offered under Plan II (comprehensive examination) after completion of course work established by the Department.

The following courses are offered in conjunction with the above programs:

UPPER-DIVISION COURSES

| | |
|---|---|
| 199 | Special Studies |

GRADUATE COURSES

| | |
|---|---|
| 207A | Problems in General and Physical Oceanography |
| 207B | Problems in General and Physical Oceanography |
| 208 | Oceanography Field Course |
| 209 | Special Topics |

| | |
|---|---|
| 210A | Physical Oceanography |
| 210B | Physical Oceanography |
| 211A | Ocean Waves |
| 211B | Ocean Waves |
| 212A | Dynamical Oceanography |
| 212B | Dynamical Oceanography |
| 213A | Radiative Transfer in the Sea |
| 213B | Radiative Transfer in the Sea |
| 214 | Introduction to Fluid Mechanics |
| 216A | Physics of Sediment Transport |
| 216B | Physics of Sediment Transport |
| 219 | Special Topics in Physical Oceanography |
| 220 | Topics in Geophysical Continuum Mechanics |
| 221 | Topics in Geophysical Fluid Dynamics |
| 222A | Hydrodynamics |
| 222B | Hydrodynamics |
| 223 | Geophysical Measurements |
| 225 | Tides and the Rotation of the Earth |
| 226A | Internal Constitution of the Earth |
| 226B | Internal Constitution of the Earth |
| 227A | Seismology |
| 227B | Seismology |
| 228 | Gravity and Geomagnetism |
| 229 | Geomagnetism |
| 240 | Marine Geology |
| 241 | Continental Margin Sediments |
| 242A | Marine Micropaleontology |
| 242B | Marine Micropaleontology |
| 243 | Marine Stratigraphy |
| 244 | Marine Geophysical Exploration |
| 245 | Sedimentary Petrology |
| 246 | Minerals and Processes of Sediments |
| 247 | Tectonics |
| 248 | Seminar in Marine Geology |
| 249 | Special Topics in Marine Geology |
| 250 | Geochemistry |
| 251 | Thermodynamics of Natural Processes |
| 252A | Nuclear Geochemistry |
| 252B | Nuclear Geophysics |
| 253A | Igneous and Metamorphic Petrology |
| 253B | Mineralogic and Petrographic Laboratory |
| 254 | Advanced Igneous Petrology |
| 255 | Crustal Evolution |
| 256A | Field Geology |
| 256B | Earth Sciences Spring Field Trip |
| 256C | Earth Sciences Summer Field Course |
| 257 | Seminar in Petrology |
| 258 | Seminar in Geology |
| 259 | Seminar in Geochemistry |
| 260 | Marine Chemistry |
| 261 | Physical Chemistry of Seawater |
| 262 | Major Sedimentary Cycle |
| 263 | Major Chemical Cycles in the Sea |
| 264 | Solids in Nature |
| 265 | Chemistry of Natural Products |
| 269 | Special Topics in Marine Chemistry |
| 270 | Biological Oceanography: Processes and Events |
| 271A | Laboratory in Biological Oceanography |
| 271B | Laboratory in Biological Productivity |
| 272 | Oceanic Zoogeography |
| 273 | Introduction to Animal Behavior |
| 274 | Population Dynamics |
| 275A | Marine Ecology |
| 275B | Marine Ecology |
| 276A | Applied Statistics |
| 276B | Applied Statistics |
| 278 | Problems in Biological Oceanography |
| 279 | Special Topics in Biological Oceanography |
| 280A | Marine Biology |
| 280B | Marine Biology |
| 282A | Advanced Invertebrate Zoology |
| 282B | Advanced Invertebrate Zoology |
| 283 | Biology of Fishes |
| 284 | Seminar in Advanced Ichthyology |
| 285 | Biology of Algae |
| 286 | Marine Microbiology |
| 287A | Ecology of Shore Microbes |
| 287B | Ecology of Shore Microbes |
| 288 | Marine Organisms, Communities and Environments |
| 288L | Laboratory in Marine Organisms |
| 289 | Special Topics in Marine Biology |
| 290 | Cellular Structure and Biochemical Function |
| 291A | Marine and Comparative Biochemistry |
| 291B | Marine Biochemistry |
| 292A | Cellular Physiology of Marine Animals |
| 292B | Cellular Physiology of Marine Animals |
| 293 | Physiology of Marine Algae |
| 294 | Selected Topics in Environmental Physiology |
| 295 | Laboratory in Physiology |
| 296 | Isotope Tracer Techniques in Physiology |
| 298 | Marine Biology Seminar |
| 299 | Research |

The instructional staff for the courses listed above consists of the following:

Ahlstrom, Elbert H., Ph.D., Adjunct Professor of Oceanography
Arrhenius, Gustaf, D.Sc., Professor of Marine Geology
Arthur, Robert S., Ph.D., Professor of Oceanography
Backus, George E., Ph.D., Professor of Geophysics
Bada, Jeffrey L., Ph.D., Assistant Professor of Oceanography
Beers, John E., Ph.D., Lecturer in Oceanography
Benson, Andrew A., Ph.D., Professor of Biology
Brinton, Edward, Ph.D., Lecturer in Oceanography
Brune, James N., Ph.D., Professor of Geophysics
Bullard, Edward C., F.R.S., Sc.D., Professor of Geophysics
Bullock, Theodore H., Ph.D., Professor of Neurophysiology
Carlucci, Angelo F., Ph.D., Lecturer in Marine Biology
Cox, Charles S., Ph.D., Professor of Oceanography
Craig, Harmon, Ph.D., Professor of Geochemistry
Curray, Joseph R., Ph.D., Professor of Oceanography
Davis, Russ E., Ph.D., Assistant Professor of Geophysics
Dayton, Paul K., Ph.D., Assistant Professor of Oceanography
Duntley, Seibert Q., Ph.D., Professor of Physics
Elsner, Robert W., Ph.D., Associate Professor of Physiology
Engel, Albert E. J., Ph.D., Professor of Geology
Enns, Theodore, Ph.D., Lecturer in

Marine Biology
Enright, James T., Ph.D., Associate Professor of Oceanography
Epel, David, Ph.D., Associate Professor of Biology
Eppley, Richard W., Ph.D., Lecturer in Oceanography
Fager, Edward W., Ph.D., D.Phil., Professor of Marine Ecology
Faulkner, David J., Ph.D., Assistant Professor of Oceanography
Fleminger, Abraham, Ph.D., Lecturer in Marine Biology
Garrels, Robert M., Ph.D., Professor of Geochemistry
Gibson, Carl H., Ph.D., Assistant Professor of Aerospace Engineering
Gieskes, Joris M. T., Ph.D., Assistant Professor of Oceanography
Gilbert, J. Freeman, Ph.D., Professor of Geophysics
Goldberg, Edward D., Ph.D., Professor of Chemistry
Hammel, Harold T., Ph.D., Professor of Physiology
Haubrich, Richard A., Ph.D., Professor of Geophysics
Hawkins, James W., Ph.D., Associate Professor of Geology
Haxo, Francis T., Ph.D., Professor of Biology
Hendershott, Myrl, Ph.D., Assistant Professor of Oceanography
Hessler, Robert R., Ph.D., Associate Professor of Oceanography
Holland, Nicholas D., Ph.D., Assistant Professor of Marine Biology
Holm-Hansen, Osmund, Ph.D., Lecturer in Marine Biology
Inman, Douglas L., Ph.D., Professor of Oceanography
Isaacs, John D., B.S., Professor of Oceanography
Keeling, Charles D., Ph.D., Professor of Oceanography
Lal, Devendra, Ph.D., Professor of Nuclear Geophysics
Lasker, Reuben, Ph.D., Associate Adjunct Professor of Marine Biology
Lewin, Ralph A., Ph.D., Professor of Biology
McGowan, John A., Ph.D., Associate Professor of Oceanography
Menard, Henry W., Ph.D., Professor of Geology
Mudie, John D., Ph.D., Assistant Professor of Geophysics
Mullin, Michael M., Ph.D., Assistant Professor of Oceanography
Munk, Walter H., Ph.D., Professor of Geophysics
Newman, William A., Ph.D., Associate Professor of Oceanography
Nierenberg, William A., Ph.D., Professor of Physics, Vice-Chancellor -- Marine Sciences, and Director -- Scripps Institution of Oceanography
Parker, Robert L., Ph.D., Assistant Professor of Geophysics
Peterson, Melvin N. A., Ph.D., Associate Professor of Oceanography
Phleger, Fred B., Ph.D., Professor of Oceanography
Raitt, Russell W., Ph.D., Professor of Geophysics
Reid, Joseph L., M.S., Lecturer in Oceanography
Riedel, William R., M.S., Lecturer in Oceanography
Rosenblatt, Richard H., Ph.D., Associate Professor of Marine Biology, Vice-Chairman
Scholander, Per F., M.D., Ph.D., Professor of Physiology
Shor, George G., Jr., Ph.D., Professor of Marine Geophysics
Somero, George N., Ph.D., Assistant Professor of Biology
Spiess, Fred N., Ph.D., Professor of Oceanography
Taft, Bruce A., Ph.D., Assistant Professor of Oceanography
Vacquier, Victor, M.A., Professor of Earth Sciences
Van Atta, Charles W., Ph.D., Associate Professor of Aerospace Engineering
Volcani, Benjamin E., Ph.D., Professor of Microbiology
Winterer, Edward L., Ph.D., Chairman and Professor of Geology
Wooster, Warren S., Ph.D., Professor of Oceanography
ZoBell, Claude E., Ph.D., Professor of Marine Microbiology

To obtain further information, address all inquiries directly to:

Graduate Department
Scripps Institution of Oceanography
Box 109
La Jolla, California 92037

## SEATTLE PACIFIC COLLEGE
### SEATTLE, WASHINGTON

The college offers marine biology courses at its main campus in Seattle, Casey Campus in Whidbey Island and at other facilities such as Friday Harbor. The Casey Campus is a part of a former U.S. Army fort near Coupeville. It encompasses more than 100 acres of wooded hills, fields, and private beach. Local accommendations include well-heated barracks, kitchen and dining facilities, gymnasium, auditorium, classrooms, outside basketball courts, track and field facilities and a large swimming pool.

Marine biology facilities include a running sea water wet laboratory and a classroom building which houses three laboratories a lecture room, office, and library. A full program of summer study in marine biology is provided. The facility is used extensively by public schools in conservation and nature study programs in the spring and fall.

The B.S. in Biology with a Marine Biology option is offered by the college. All students are required to take General Biology 201 and 202 or the equivalent, Biology 301 (Microbiology) or Biology 460 (Molecular Biology), Biology 310 (Ecology), Biology 320 (Developmental Biology) or Biology 371 (Genetics) and 25 additional quarter hours in upper division biology plus departmental seminar. Chemistry through organic is required.

The following courses are offered in conjunction with the above program:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 400 or 500 | Marine Problems | 3-5 |
| 432 | Marine Invertebrate Biology | 5 |
| 444 | Marine Botany | 5 |
| 450 | Environmental Physiology | 5 |
| 510 | Marine Ecology | 5 |

The instructional staff for the courses listed above consists of the following:

Bruce, David S., Ph.D., Environmental Physiology
Martin, Gordon W., Ph.D., Invertebrate Biology
Phillips, Ronald, Marine Botany and Ecology
Shaw, Ross F., Ph.D., Invertebrate Biology and Director of Casey Campus

To obtain further information, address all inquiries directly to:

Dr. Ross Shaw
Director of Marine Biology Program
Seattle Pacific College
Seattle, Washington 98119

## UNIVERSITY OF SOUTH FLORIDA
## MARINE SCIENCE INSTITUTE
### ST. PETERSBURG, FLORIDA

The Marine Science Institute of the University of South Florida is located at the Bay Campus in St. Petersbug. The Institute is an interdisciplinary unit involving the cooperation of seven associated departments in three divisions of the University.

The Bay Campus occupies a peninsula about one block wide and two blocks long that extends into Bayboro Harbor, a protected bay opening into Tampa Bay. There are 15 buildings of various sizes with more than 200,000 square feet of floor space. Offices and laboratories are located in the main building. There are five new marine science teaching laboratories and six research laboratories, classrooms, living quarters for about 20 visiting investigators, an auditorium, and many other facilities.

Excellent docking and servicing facilities for oceanographic vessels and smaller boats surround the Bay Campus. The Institute operates a 38-foot catamaran, several smaller boats, and has access to larger vessels through the Florida Institute of Oceanography. At the dockside is a concrete seawater tank with water filtration system.

A Master's degree in Marine Science is offered by the Institute. Each student is required to satisfactorily complete 45 quarter hours of graduate level courses which must include the four basic courses in biological, chemical, geological, and physical oceanography. A student will normally undertake a thesis project in one of these basic disciplines which carries 9 quarter hours credit. The student must satisfactorily defend his thesis, prior to its acceptance, before a committee appointed by the department.

The Institute also offers an extensive summer session with a broad selection of field oriented courses in Marine Science.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| BOT 447 | Marine Botany | 4 |
| BOT 543 | Phycology | 5 |
| BOT 583 | Marine Microbiology | 4 |
| BOT 643 | Advanced Phycology | 4 |
| CHM 613 | Chemistry of the Less Familiar Elements | 4 |
| GLY 503 | Sedimentation I | 3 |
| GLY 504 | Sedimentation II | 3 |
| GLY 604 | Recent Fluvial, Transitional and Continental Shelf Sedimentation | 3 |
| GLY 605 | Advanced Sedimentation | 3 |
| GLY 621 | Marine Micropaleontology | 6 |
| OGY 311 | Introduction to Oceanography | 3 |
| OGY 521 | Chemical Oceanography | 4 |
| OGY 531 | Geological Oceanography | 4 |
| OGY 541 | Physical Oceanography | 4 |
| OGY 551 | Biological Oceanography | 4 |
| ZOO 519 | Ichthyology | 5 |
| ZOO 523 | Physiology of Marine Animals | 5 |
| ZOO 533 | Physiology of Fishes | 4 |
| ZOO 546 | Marine Invertebrate Zoology I | 5 |
| ZOO 547 | Marine Invertebrate Zoology II | 5 |
| ZOO 613 | Advanced Invertebrate Zoology | 3 |
| ZOO 614 | Plankton Ecology | 4 |
| ZOO 615 | Plankton Systematics | 4 |
| ZOO 619 | Advanced Ichthyology | 5 |

The instructional staff for the courses listed above consists of the following:

Baird, Ronald C., Ph.D., Assistant Professor of Marine Science
Betz, John V., Ph.D., Assistant Professor of Botany and Bacteriology
Bloch, S.C., Ph.D., Associate Professor of Physics
Briggs, John C., Ph.D., Chairman and Professor of Zoology
Carder, Kendall L., Ph.D., Assistant Professor of Marine Science
Dawes, Clinton J., Ph.D., Associate Professor of Botany
Flynn, Robert W., Sc.D., Assistant Professor of Physics
Friedl, Frank E., Ph.D., Associate Professor of Zoology
Hopkins, Thomas L., Ph.D., Assistant Professor of Marine Science
Humm, Harold J., Ph.D., Director, and Professor of Marine Science
Lawrence, John M., Ph.D., Assistant Professor of Zoology
Linton, Joe R., Ph.D., Associate Professor of Zoology
Martin, Dean F., Ph.D., Associate Professor of Chemistry
Merner, Diane T., Ph.D., Assistant Professor of Biology
Pyle, Thomas E., Ph.D., Assistant Professor of Marine Science
Simon, Joseph L., Ph.D., Assistant Professor of Zoology
Strong, Paschal, Ph.D., Professor of Psychology
Taft, William H., Ph.D., Director and Associate Professor, Sponsored Research; Assistant Dean of Academic Affairs

To obtain further information, address all inquiries directly to:

Dr. Harold J. Humm
Director
Marine Science Institute
University of South Florida
830 First Street South
St. Petersburg, Florida 33701

## SOUTHEASTERN MASSACHUSETTS UNIVERSITY
### NORTH DARTMOUTH, MASSACHUSETTS

The research building on the North Dartmouth campus provides several constant temperature aquatic rooms which house salt water aquarium facilities. These aquatic rooms and other special purpose rooms, housing apparatus for physiological measurements of fish and marine invertebrates are available to graduate students. The University research vessel, the 65-foot

RV CORSAIR is berthed at the nearby New Bedford seaport. Equipped with recording sonar and standard hydrographic instruments CORSAIR has been modified as a stern trawler for fisheries sampling operations. Smaller craft, including a 16-foot Boston Whaler, are moored on estuaries near campus and are employed in estuarine studies. The University recently acquired a 20-acre waterfront site on Gooseberry Island, Westport, Massachusetts, and plans to build a specialized marine laboratory at the Westport location. The main campus at North Dartmouth is so situated that students and researchers can reach salt water, estuarine and fresh water environments within a few miles distance from campus.

The University offers the following degrees:

1. B.S. - Marine Science Option in Biology
2. M.S. in Marine Biology. Each graduate student plans his course work and research program with the assistance of his advisor. Selection of courses and research problems is correlated with the background and occupational objectives of the student. Although all graduate students are urged to carry out a research project and write a Master's thesis, it is possible for students who do not contemplate a career in research to earn their Master's degree on the basis of successful completion of course work.

A minimum of thirty credits and a grade point average of 3.0 are required of all Master's degree candidates. Students are encouraged to include appropriate course selections in mathematics, the physical sciences and engineering as well as in biology.

A limited number of approved undergraduate courses are accepted for credit toward graduate degree requirements.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 314 | General Ecology | 4 |
| 315 | The Biology of the Algae | 4 |
| 317 | The Biology of Invertebrate Animals | 4 |
| 406 | Life in the Seas I | 3 |
| 407 | Life in the Seas II | 3 |
| 411 | Proseminar: Current Topics in Biology | 1-3 |
| 413 | The Biology of Fishes | 4 |
| 414 | Comparative Physiology | 4 |
| 415 | Limnology | 4 |
| 416 | Life in the Seas, Lab I | 1 |
| 417 | Life in the Seas, Lab II | 1 |
| 430 | Design of Experiments | 4 |
| 440 | Research Project | 2 |
| 509 | Directed Study in Biology | 1-2 |
| 511 | Graduate Seminar in Biology | 1-3 |
| 517 | Advanced Biology of Invertebrate Animals | 4 |
| 520 | Animal Behavior | 3 |
| 521 | Microbial Ecology | 4 |
| 531 | Advanced Ichthyology | 4 |
| 544 | General Oceanography | 4 |
| 545 | Biological Oceanography | 4 |
| 593 | Graduate Research Project | 1-3 |
| 599 | Graduate Thesis | 10 Max |

The University also offers undergraduate programs in Ocean Engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Corbeil, Lynette, D.V.M., Assistant Professor
Corbeil, Robert, Ph.D., Associate Professor
Cotter, David, Ph.D., Assistant Professor
Cox, James, Ph.D., Assistant Professor
Daly, Kevin, Ph.D., Associate Professor
Edgar, Robert, Ph.D., Assistant Professor
Hoff, James, Ph.D., Associate Professor
Morse, Stephen, Ph.D., Assistant Professor
Moss, Sanford, Ph.D., Assistant Professor
Mulcare, Donald, Ph.D., Assistant Professor
O'Brien, Francis, M.S., Instructor
Reardon, John J., Ph.D., Chairman and Professor
Sasseville, Normand, Ed.M., Professor
Szal, Roger, Ph.D., Assistant Professor
Whitaker, Ellis, Ph.D., Associate Professor

To obtain further information, address all inquiries directly to:

(Concerning Undergraduate Studies in Marine Biology)

Dr. John J. Reardon
Chairman, Department of Biology
Southeastern Massachusetts University
North Dartmouth, Massachusetts 02747

(Concerning Graduate Curriculum in Marine Biology)

Dr. James G. Hoff
Coordinator, Graduate Studies
Biology Department
Southeastern Massachusetts University
North Dartmouth, Massachusetts 02747

## UNIVERSITY OF SOUTHERN CALIFORNIA
## UNIVERSITY PARK
### LOS ANGELES, CALIFORNIA

The University offers marine science courses at both its main campus in downtown Los Angeles and at its new Marine Sciences Center on Santa Catalina Island, 22 miles offshore from the Los Angeles Coastal Plain. The University was founded in 1880, and marine research and course work was organized in the early 1900's. The impetus for a much expanded effort in marine sciences came with the gift of the research vessel VELERO III and the endowment of the Hancock Foundation in 1939 by Captain G. A. Hancock. Following the requisitioning of the VELERO III as a patrol craft in World War II, Captain Hancock built a new research ship, launched in 1948, and given to the University. The VELERO IV is based on the utilitarian Pacific Tuna Clipper design but was built from the keel up for ocean research. The ship is 110 feet long and provides berthing for a crew of 11 and nine scientists. Complete equip-

ment is provided by individual departmental and special project groups. The ship operations are administered by the Hancock Foundation and funded by the National Science Foundation. The VELERO IV was the first ship block funded by the National Science Foundation, establishing the present general national system. In addition to the VELERO IV, a coastal research vessel, the GOLDEN WEST, a 43-foot converted charter fisheries boat, is also maintained by the Foundation. A fast, husky motor cruiser, the ESPOIR, 34 feet long, is used for transporting personnel to and from the Marine Laboratory at Catalina. The two small vessels have full-time skippers, and a technician-seaman is also provided aboard the GOLDEN WEST. The latter has complete navigation and communication equipment as well as small hydrographic winch with 1,000 meters of stainless wire. The VELERO IV is equipped with several winches, the largest being capable of working to depths of 4,000 meters with loads of up to a few tons for heavy trawling, dredging, and coring.

The Catalina Marine Science Center is a newly established research facility for marine sciences at Santa Catalina Island. The Center is operated academically on a consortium basis. Participating institutions include: University of California campuses at Los Angeles, Irvine, and Riverside, California Institute of Technology, Pomona College, Occidental College, and the University of Southern California. The California state college system has also appointed a liaison representative. Students are drawn from all participating institutions by registering through their home universities. Teaching staff assignments are also made by the members of the consortium from their own faculties. Courses offered at Catalina are listed in the catalogs of all participating institutions, and reciprocal credit is automatically granted. Subcommittees of the Inter-University Advisory Committee provide assistance in planning for academic programs as well as site development and other planning and operational functions. There is about 10,000 square feet of laboratory space equipped with running sea water and with facilities for research of all types including electron microscopy. A fully equipped locker for diving is supported with underwater equipment for photography, television camera studies, and acoustics. A permanent staff is in residence and space for up to 32 students and a dozen researchers is available. The first building, the Santa Catalina Marine Biological Laboratory, has been completed and its educational and research programs are being managed by the Department of Biological Sciences and the Allan Hancock Foundation.

Specialized laboratories for various areas of Marine Geology, Geophysics, Geochemistry, Ecology, and Oceanography are located in the spaces of the Department of Geological Sciences on campus. Ocean Engineering and Coastal Engineering laboratories are active in the School of Engineering and several specialized Biological Sciences laboratories are located in Old Science Hall. The Hancock Foundation Building houses some of the Marine Geology and Paleoecology Laboratories as well as the bulk of the Marine Biology facilities. The Sea Grant Institutional Program is also headquartered in the Foundation Building.

A major computer facility and several excellent libraries including the Hancock Library for Oceanography and Marine Biology round out a very broad spectrum of facilities on the main campus.

The Law Center is in the process of acquiring a library of materials relating to pollution and resource management of the marine environment. The Library will have several hundred volumes, including serials, and will be separately shelved in the law library.

The following degrees are offered by the Departments indicated:

1. Ph.D. in Geology with specialization in Marine Geology, Geophysics, and Geochemistry of the Oceans (Department of Geological Sciences).
2. Ph.D. in Oceanography (by special arrangement between the Department of Geological Sciences and the Marine Sciences Program).

The requirements for the doctorate follow the general requirements of the Graduate School and generally require a minimum of four years to complete. Only students of high ability are accepted as candidates after demonstrating their competence in a screening examination in the first year, a comprehensive written and oral examination after two years, and the successful defense of an original dissertation. Depending on the program, the student is required to either successfully demonstrate a reading knowledge of two foreign languages, or may substitute competence in statistics and computer use, or in advanced basic science minors. The path of a student's studies will be directed by a guidance committee following the successful passing of the screening examination.

Entrance to the graduate program is based on a bachelor's degree from an accredited college or university, high grade point average and a minimum level of attainment on the Graduate Record Examination.

3. M.S./M.A. in Geological Sciences with specialization in Marine Geology and Oceanography (Department of Geological Sciences).

Master's degree candidates must have the same entrance qualifications as above, and must have passed 24 hours of graduate course work with a grade point average of 3.0/4.0. A thesis is required. The Master's committee is selected after the screening examination of the first year is successfully passed. The Master's is generally required before the Ph.D. can be sought except in exceptional cases of ability. A Master's degree normally requires two years to complete.

4. B.S., M.S., and Ph.D. in Biological Sciences with specialization in marine sciences (Department of Biological Sciences).

Degrees at the Master's and Doctoral level are offered. After admission to the program, students are given a background examination in the major fields of Biology. Students prepare a curriculum of course and research training in consultation with their advisor and a guidance committee. Although the qualifying examination in the second year is common to all doctoral students, there is considerable specialization by those engaged in areas of Marine Science. Shipboard experience as well as teaching assistant experience is required for students engaged in relevant oceanic biology research areas. A thesis topic demonstrating an ability to undertake independent research is demanded. The areas of research are defined mainly by faculty interests and include marine ecology

and biosystematics, ichthyology, biological oceanography, marine pollution and productivity, and comparative physiology.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

DEPARTMENT OF GEOLOGICAL SCIENCES

| | | |
|---|---|---|
| 107L | Elements of Oceanography | 4 |
| 408 | Applied Mathematics for Geologists | 4 |
| 440 | General Geophysics | 4 |
| 460L | Geochemistry | 4 |

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 301L | Fundamentals of Invertebrate Biology | 4 |

GRADUATE COURSES

DEPARTMENT OF GEOLOGICAL SCIENCES

| | | |
|---|---|---|
| 500L | Marine Paleoecology | 4 |
| 510 | Sedimentary Processes | 4 |
| 511L | Sedimentary Techniques | 4 |
| 512 | Introductory Oceanography | 4 |
| 514 | Marine Geology | 4 |
| 529 | Terrestrial Heat Flow | 4 |
| 531 | Geotectonics | 4 |
| 536 | Seminar in Engineering Geology | 4 |
| 537L | Applied Geophysics | 4 |
| 540 | Physics of the Earth's Interior | 4 |
| 563L | Chemical Oceanography | 4 |
| 577L | Micropaleontology | 4 |
| 578L | Advanced Micropaleontology | 4 |
| 600 | Seminar | 4 |
| 610 | Probability and Stochastic Processes for Geophysicists | 4 |
| 640 | Advanced General Geophysics | 4 |

DEPARTMENT OF BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| 508 | Invertebrate Marine Zoology | 4 |
| 531 | Seminar in Marine Invertebrate Zoology | 4 |
| 541L | Protozoology | 4 |
| 542L | Ichthyology | 4 |
| 546L | Crustacean Biology | 4 |
| 547 | Malacology | 4 |
| 560L | Marine Invertebrate Physiology | 4 |
| 573L | Marine Ecology | 4 |
| 574 | Marine Plankton Ecology | 4 |

CATALINA MARINE BIOLOGY LABORATORY

| | | |
|---|---|---|
| 520L | Marine Botany | 5 |
| 560L | Marine Invertebrate Physiology | 5 |
| 561 | Physiological Ecology of Marine Organisms | 5 |
| 564L | Digestion and Feeding in Marine Invertebrates | 5 |
| 565L | Biology of Marine Vertebrates | 5 |
| 567L | Marine Plankton Ecology | 5 |
| 568L | Advanced Marine Invertebrate Biology | 5 |
| 572L | Marine Ecology | 5 |
| 580L | Special Topics in Marine Biology | 5 |
| 581 | Oceanology | 5 |
| 519 | Recent Advances in Marine Biology | 5 |

ORGANIZATION FOR TROPICAL STUDIES

| | | |
|---|---|---|
| 522L | Tropical Marine Biology | |

LAW CENTER

| | | |
|---|---|---|
| | Local Government Law | 3 |
| | Legal Problems of Coast and Tidelands Resources: Policies and Procedures for Reconciling Economic Development and Environmental Quality | 3 |
| 728 | Admiralty | 2 |
| 663 | Law of World Organizations | 2 |
| 861 | International Law Seminar | 2 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF GEOLOGICAL SCIENCES

Bandy, Orville L., Ph.D., Chairman and Professor of Geological Sciences
Bischoff, James L., Ph.D., Associate Professor of Geochemistry
Gorsline, Donn S., Ph.D., Professor of Marine Geology
Henyey, Thomas L., Ph.D., Assistant Professor of Geophysics
Ku, Richard T., Ph.D., Associate Professor of Geochemistry
Pipkin, Bernard W., Ph.D., Senior Lecturer in Geological Sciences
Teng, Ta-liang, Ph.D., Associate Professor of Geophysics

DEPARTMENT OF BIOLOGICAL SCIENCES

Abbott, Bernard C., Ph.D., Professor and Chairman, and Director, Allan Hancock Foundation
Bakus, Gerald J., Ph.D., Associate Professor
Fauchald, Kristian, Ph.D., Assistant Professor
Fernandez Y. Cossio, Hector R., Ph.D., Assistant Professor
Garth, John S., Ph.D., Professor
Mohr, John L., Ph.D., Professor
Nafpaktitis, Basil G., Ph.D., Associate Professor
Nicholson, Nancy L., Ph.D., Assistant Professor

ALLAN HANCOCK FOUNDATION

Fauchald, Kristian, Ph.D., Curator of Polychaetes
Garth, John S., Ph.D., Senior Curator and Curator of Crustaceans
Hartman, Olga, Ph.D., Emeritus Curator of Polychaetes
Mohr, John L., Ph.D., Curator of Protozoa
Nicholson, Nancy L., Ph.D., Curator of Algae
Savage, Jay M., Ph.D. Associate Director
Soule, John D., Ph.D., Curator of Bryozoa
Straughan, Dale M., Ph.D., Principal Investigator, Oil Pollution
Ziesenhenne, Fred C., Curator of Echinoderms

SANTA CATALINA MARINE BIOLOGICAL LABORATORY

Given, Robert R., Ph.D., Assistant Director
Zimmer, Russel L., Ph.D., Resident Director

LAW CENTER

POLITICAL SCIENCE DEPARTMENT

Christol, Carl Q., Ph.D., Professor of Political Science and International Law

LAW SCHOOL

Bradley, Lawrence, LL.B., Practicing Lawyer and Part-time Instructor
Ellickson, Robert, LL.B., Assistant Professor of Law
Tarlock, A. Dan, LL.B., Visiting Associate Professor of Law

To obtain further information, address all inquiries directly to:

Dr. Bernard C. Abbott
Director, Allan Hancock Foundation
Chairman, Department of Biological Sciences
University of Southern California
University Park
Los Angeles, California 90007

## THE UNIVERSITY OF SOUTHERN MISSISSIPPI
HATTIESBURG, MISSISSIPPI

The Department of Biology operates in an area of 35,000 square feet representing both labs and classrooms; however, an additional 31,000 square feet of space in a new science building will be available early in 1971. The University is closely affiliated with the Gulf Coast Research Laboratory at Ocean Springs, Mississippi (90 miles away). This association allows use of the research vessels HERMES and GULF RESEARCHER, plus space, equipment and library facilities at the GCRL. The Department also utilizes the facilities of the Bureau of Commercial Fisheries' vessel, R/V OREGON II, on a space available basis.

The Department of Geology, which occupies 18,000 square feet of laboratories, offices, and classrooms in the Science Building also cooperates closely with the GCRL and is extended the use of GCRL facilities.

The following degrees are offered in the basic sciences:

1. Ph.D. in Marine Biology. The Department of Biology offers a Doctor of Philosophy degree with majors in marine biology and in zoology. All doctoral degrees entail a minimum of 118 quarter hours of course work beyond the bachelor's degree or 72 quarter hours of course work beyond the master's degree. Forty-eight quarter hours must be spent on the Hattiesburg campus. A final oral examination is administered after the dissertation has been accepted.
2. M.A., M.S. in Biology. Candidates for the Master of Arts or Master of Science degrees must earn 46 quarter hours of graduate credit, 16 hours of which should be in a minor area. A final oral comprehensive examination and an acceptable thesis are required.
3. M.A., M.S. in Geology. Candidates for the Master of Arts or Master of Science degrees must earn 46 quarter hours of graduate credit. For the Master of Arts degree a candidate must take 16 hours of an approved academic minor, demonstrate proficiency in a foreign language, and present an acceptable thesis. For the Master of Science degree, a candidate must elect a minor (16 hours) in an approved field and present an acceptable thesis which must be defended.

Marine science courses are offered by the departments of Biology and Geology during the regular academic year. Summer courses in marine biology and geology are offered at the Gulf Coast Research Laboratory. Credits are in quarter hours.

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 479 | Introduction to Biological Oceanography | 4 |
| 429 | Marine Botany (GCRL) | 4.5 |
| 431 | Marine Vertebrate Zoology (GCRL) | 9 |
| 454 | Marine Invertebrate Zoology I (GCRL) | 9 |
| 454 | Marine Invertebrate Zoology II (GCRL) | 9 |
| 515 | Biological Oceanography | 4 |
| 560 | Topics in Marine Biology | 2 |
| 563 | Fisheries Biology | 4 |
| 567 | Marine Ecology | 4 |
| 568 | Planktology | 4 |
| 582 | Physiology of Marine Animals | 4 |
| 592 | Special Problems in Biology I, II, III, IV | 8 |
| 598 | Thesis | 6 |
| 601 | Research Zoology | 12 max |
| 604 | Research in Marine Biology | arr |
| 791 | Research in Biology | 12 max |
| 792 | Special Problems | 4 |
| 798 | Dissertation | |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 420 | Sedimentology | 4 |
| 452 | Physical Marine Geology (GCRL) | 9 |
| 453 | Chemical Marine Geology (GCRL) | 9 |
| 454 | Problems in Marine Sedimentation (GCRL) | 9 |
| 479 | Introduction to Geological Oceanography | 4 |
| 485 | Problems in Geology | 4 |
| 540 | Sedimentary Environments | 4 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Cliburn, Joseph W., Ph.D., Professor of Biology
Fischer, Barbara A., Ph.D., Assistant Professor of Biology
Fish, Arthur G., Ph.D., Associate Professor of Biology
Grantham, Billy J., Ph.D., Assistant Professor of Biology
Pessoney, George F., Ph.D., Chairman and Associate Professor of Biology
Thompson, John R., Ph.D., Assistant Professor of Biology

DEPARTMENT OF GEOLOGY

Bowen, Richard L., Ph.D., Chairman and Professor of Geology
Hoskin, Charles M., Ph.D., Associate Professor of Geology
Paulson, Oscar L., Ph.D., Associate Professor of Geology

To obtain further information, address all inquiries directly to:

Dr. R. VanAller
Dean of the Graduate School
University of Southern Mississippi
Hattiesburg, Mississippi 39401

## ST. JOHN'S UNIVERSITY
### JAMAICA, NEW YORK

The University offers marine science courses at the Jamaica campus and encourages advanced students to undertake field work at the New York Ocean Science Laboratory, Montauk, New York. The Departments of Biology, Chemistry, and Physics and the College of Pharmacy are located in the science building which contains complete laboratory and classroom facilities for instruction and research. In another building there is storage space for two collecting boats and their trailers. A 12-foot aluminum skiff with outboard engine is suitable for estuarine and bay waters. A 17-foot fiberglass, general purpose boat with inboard stern drive engine is suitable for almost all local waters. The Biology Department has arranged for the use of facilities at the New York Ocean Science Laboratory where additional research vessels are available.

The following degrees are offered by the Department of Biology:

1. Ph.D. in Marine Biology. All students are required to do research in some aspect of marine biology and must pass a written comprehensive examination in their field of study. An oral examination is also given on the subject matter of the doctoral dissertation. The course requirements are determined by a special faculty committee on the basis of the professional objectives of the individual student. A minimum of 69 semester hours of graduate course work beyond the bachelor's degree or a minimum of 36 semester hours beyond the Master's degree must be taken in the program. The student must also demonstrate an ability to read two of the following languages: French, German, and Russian.
2. M.S. in Marine Biology. All students take a special research course in some aspect of marine biology and must pass a comprehensive examination in their field of study. A minimum of 33 semester hours of graduate courses beyond the bachelor's degree must be taken in the program. At present there is no formal dissertation or language requirement for this degree.
3. B.S. in Biology (with special emphasis on Marine Biology). This is the regular program for biology majors who may elect to take some courses and research in Marine Biology and related subjects.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 23 | Invertebrate Zoology | 4 |
| 33 | Marine Biology | 4 |
| 37 | Ecology | 2 |
| 38 | Biological Techniques | 2 |
| 40 | Research in Biology | 2 |
| 41 | Research in Biology | 2 |

GRADUATE COURSES

| | | |
|---|---|---|
| 205 | Microbial Physiology | 3 |
| 206 | Microbial Physiology | 3 |
| 209 | Protozoology | 3 |
| 226 | Marine Microbiology | 3 |
| 246 | Marine and Fresh Water Invertebrates | 3 |
| 247 | Marine and Fresh Water Invertebrates | 3 |
| 249 | Marine Environmental Biology | 3 |
| 250 | Marine Environmental Biology | 3 |
| 251 | Biological Problems of the Urban Environment | 3 |
| 252 | Biological Problems of the Urban Environment | 3 |
| 344 | Special Research in Zoology | 3 |
| 345 | Special Research in Zoology | 3 |
| 406 | Seminar in Experimental Zoology | 3 |
| 401 | Seminar in Experimental Zoology | 3 |
| 450 | Dissertation Research | 3 |
| 451 | Dissertation Research | 3 |
| 452 | Dissertation Research | 3 |
| 453 | Dissertation Research | 3 |

Graduate courses and research taken at New York Ocean Science Laboratory, Montauk, New York or at Marine Biological Laboratory, Woods Hole, Massachusetts or at other recognized marine laboratories will be accepted for credit.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Concannon, Joseph N., Ph.D., Associate Professor, Parasitic Protozoa and Radiobiology
D'Agostino, Anthony S., Ph.D., Associate Professor, Marine Invertebrate Physiology and Nutrition
Frascella, Daniel W., Ph.D., Assistant Professor, Vertebrate Physiology
Jack, R. Cecil M., Ph.D., Associate Professor, Biochemistry of Lipids and Membranes
Liberti, Alfred V., Ph.D., Chairman and Professor of Biology
Lilly, Daniel M., Ph.D., Professor, Protozoology and Marine Microbiology
Pisano, Michael A., Ph.D., Professor Microbial Biochemistry and Physiology
Rio, Guido J., Ph.D., Assistant Professor Fish Viruses and Microbiology

To obtain further information, address all inquiries directly to:

Professor Daniel M. Lilly
Department of Biology
St. John's University
Grand Central and Utopia Parkways
Jamaica, New York 11432

## HOPKINS MARINE STATION OF STANFORD UNIVERSITY
### PACIFIC GROVE, CALIFORNIA

The station occupies an exposed rocky headland, Mussel Point. The University holds title to about 11 acres on and around the point, which includes approximately one mile of shoreline. The intertidal and offshore waters surrounding the Marine Station, rich in marine life, are protected by law as a marine reserve, and provide excellent resources for research and teaching in marine biology. The Station operates as a branch of the Department of Biological Sciences of the University. The teaching and research

facilities at the Station are housed in three main buildings. The Agassiz Laboratory provides space and equipment for studies in the biology and ecology of marine invertebrates, fishes and algae. A three-story concrete structure, it contains three large teaching laboratories and office and research space for staff, graduate students, and visiting investigators. Special facilities include rooms equipped for microtechnique and photomicrography, a large aquarium room, a reference collection of marine invertebrates, and the Gilbert M. Smith herbarium of marine algae. The two-story Jacques Loeb Laboratory provides rooms and other facilities for experimental studies on the development, physiology, and biochemistry of marine animals, plants, and microorganisms. Cold rooms, constant temperature rooms, and a photographic darkroom are available. The laboratories are equipped with a wide variety of specialized equipment including a gas chromatograph, recording spectrophotometers, radiation counting equipment, high speed refrigerated centrifuges, a preparative ultracentrifuge, neurophysiological equipment, and facilities for electrophoresis and chromatography. The Marinostat houses two large laboratories, 10 smaller research rooms, and six dark laboratories now being equipped for experimental temperature and light regimes. In addition to seawater at normal ocean temperatures, all laboratories are supplied with refrigerated seawater for maintaining lower temperatures. The library is housed on the upper floor of the Jacques Loeb Laboratory. It contains a constantly expanding collection of books in the fields most under study (algology, invertebrate zoology, development, ecology, physiology, biochemistry, microbiology, and biological oceanography). The collection currently consists of some 12,000 volumes. About 450 serial publications in these fields are received.

The research vessel PROTEUS, a 96-foot motor vessel with a 6,000 mile range, provides the base for graduate training in biological oceanography. The ship carries a scientific party of 9 and is outfitted as a floating laboratory for observation, collection, experimentation, and teaching. Deepsea trawling and hydrographic winches permit sampling at depths of up to 6,000 meters. The ship is equipped with a variety of gear for physical measurement, chemical analysis, and the collection, examination, and maintenance of living organisms. In addition a small reference library is carried which is changed to suit the needs of each cruise. Several skiffs and a launch and diving equipment are carried for inshore work.

Two smaller research vessels, the TAGE, a 40.5-foot launch, and a 26-foot whaler are equipped with winches and oceanographic equipment for more limited studies in Monterey Bay. Several small skiffs are available for inshore work.

The Station offers the degree of Doctor of Philosophy in Biology, with specialization in algology, invertebrate zoology, development, ecology, physiology, biochemistry, or biological oceanography.

In addition the Station provides: (a) courses in marine biology and biological oceanography designed for matriculated and non-matriculated undergraduates and graduate and professional biologists during the summer quarter; (b) a program of training in research for matriculated and non-matriculated undergraduates and graduates in biology during the spring (Biology 175H) and summer quarters (Biology 176H and 199H); students, after completion of Biology 175H, may continue their research during the summer by enrolling in Biology 176H or 199H; (c) a program of graduate study and research in marine biology and biological oceanography leading to the degrees of Master of Arts and Doctor of Philosophy during all four quarters.

The following courses are offered in conjunction with the above programs:

| | |
|---|---|
| 100H | Marine Algae |
| 111H | Marine Invertebrates |
| 112H | Marine Invertebrates (continued) |
| 118H | Phytoplankton |
| 119H | Marine Ecology |
| 120H | Marine Ecology (continued) |
| 176H | Problems in Biological Oceanography |
| 199H | Special Problems |
| 222H | Biological Oceanography |
| 261H | Comparative Biochemistry of Marine Organisms |
| 269H | Ecological Physiology |
| 300H | Research |

The instructional staff for the courses listed above consists of the following:

Abbott, Donald Putnam, Ph.D., Professor of Biology and Associate Director, Hopkins Marine Station.
Abbott, Isabella Aiona, Ph.D., Research Biologist.
Gilmartin, Malvern, Ph.D., Professor of Biology.
Lee, Welton L., Ph.D., Assistant Professor of Biology.
Martin, John H., Ph.D., Senior Scientist.
Phillips, John H., Ph.D., Professor of Biology and Director, Hopkins Marine Station.
Fournier, Robert O., Ph.D., Visiting Assistant Professor of Biology.
Pearse, John Stuart, Ph.D., Visiting Assistant Professor of Biology.

To obtain further information, address all inquiries directly to:

John H. Phillips, Director
Hopkins Marine Station
Pacific Grove, California 93950

## SUFFOLK UNIVERSITY
### BOSTON, MASSACHUSETTS

The university offers course work in the marine sciences at its Boston location and at the marine field station at Edmunds, Maine. The main campus has laboratory facilities which have recently been modernized and expanded through renovation of pre-existing facilities. The renovation has provided new facilities in the form of an environmental room for maintaining marine organisms, A.E.C. licensed facilities for radiobiological studies and additional laboratories for marine and non-marine studies. The chemistry and physics departments have had a comparable growth and development. The Edmunds, Maine facility is presently under development as an 18 acre waterfront facility on the shores of Cobscook Bay. This location is unique in that the greatest tide fluctuations in the

continental U.S. are experienced at this location. A 43' converted trailer serves as the temporary laboratory with all utilities present. An outdoor circulation sea water system is in operation which allows for limited activities with living organisms. At the present time the facility is principally a camping field station. The New Hampshire Colleges and University Council - Suffolk University consortium for marine sciences is cooperating in the development and use of this station. The purposes of the station are to serve undergraduate and teacher education interest. Visiting scientists are welcome to use the facilities for research purposes.

Suffolk University offers 3 degree programs which allow for course work in the marine sciences: B.A., B.S., and M.A. in Education. These programs are mostly identified with the biology curriculum and to a large extent with teachers in-service as science teachers. No degrees are offered in oceanography or marine sciences.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE

| | |
|---|---|
| 2.1 | Introduction to Marine Sciences |
| *3.5 | Ecology |
| *3.9 | Physiological Ecology |
| *4.1 | General Physiology |
| *4.2 | General Physiology |
| *4.3 | Invertebrate Zoology |
| *4.4 | Invertebrate Zoology |

ADVANCED UNDERGRADUATE/GRADUATE

| | |
|---|---|
| *3.3 | Parasitology |
| *4.8 | Radiobiology |
| 4.9 | Natural History of Marine Invertebrates |
| 5.0 | Seminar |

GRADUATE

| | |
|---|---|
| S6.0 | Biology of Marine Organisms |

* These courses consist of several different topics, some of which are marine related.

Course Work is also available through an interinstitutional program which is funded under a National Science Foundation College Science Improvement Program (COSIP). This program operates under the New Hampshire Colleges and University Council with Suffolk University as an affiliate member through the Marine Sciences Committee of the Consortium.

The instructional staff for the courses listed above consists of the following:

Comeau, Gerald, A.S., Lecturer in Biology
Friedman, Robert S., Ph.D., Professor of Biology
Johnson, Randolph, M.S., Lecturer in Biology
Maehl, Richard H., Ph.D., Professor of Chemistry
Mulvey,Phillip F., Jr., Ph.D., Professor of Biology
Snow, Beatrice L., M.S., Assistant Professor of Biology
West, Arthur J. II, Ph.D., Chairman and Professor of Biology

Special Guest Lecturers in the 6.0 course include:

Geraci, Joseph R., Ph.D., Marine Vertebrates
Lamb, I. MacKenzie, D.Sc., Marine Algology
Sherman, Kenneth A., M.S., Biological Oceanography
Simon, Joseph L., Ph.D., Marine Invertebrates

To obtain further information, address all inquiries directly to:

Mr. William F. Coughlin
Director of Admissions
Suffolk University
41 Temple Street
Boston, Mass. 02114

## TEXAS A&M UNIVERSITY
### COLLEGE STATION, TEXAS

The University's Department of Oceanography is housed in two buildings on the main campus in College Station. Construction has started on a 12-story building to house the Departments of Oceanography and Meteorology. It is scheduled for completion by September 1972. The facilities available to students include the Texas A&M Marine Laboratory at Galveston, a fully-equipped 180-foot research vessel R/V ALAMINOS, and the 98-foot research vessel ORCA used for shallow water and coastal research.

The University offers courses in marine biology at both the main campus at College Station and its Marine Laboratory at Galveston, Texas (140 miles from the main campus). A new wing to the Biological Sciences Building was completed in 1967 and includes modern laboratory facilities for teaching and research in marine biology. A computerized fish behavior facility has been in operation in the Biological Sciences Building since 1968. The Marine Laboratory at Galveston offers facilities for research and teaching with running sea water available for collecting and research trips. The Biology Department maintains cooperative degree programs and conducts research with the Departments of Wildlife Science and Civil Engineering (Environmental Engineering Section).

The Marine Laboratory, which was established in Galveston in 1953, is an interdepartmental institution of Texas A&M University. The program is devoted to year-round research and instruction, both graduate and undergraduate, in various disciplines related to Marine Science. The Laboratory shares a 65,000 square foot building with the Texas Maritime Academy. Facilities available to students include the R/V ALAMINOS, R/V ORCA, and 50-foot yacht, MARINER. Various phases of the NSF Sea Grant Program of Texas A&M University are conducted at the Galveston facility. Cooperative research and/or teaching programs are conducted with other educational and research institutions in Galveston, including the National Marine Fisheries Service (formerly Bureau of Commercial Fisheries); Galveston College; the Marine Biomedical Institute, the Medical Branch of the University of Texas; and Texas Maritime Academy. Certain facilities and resources of these institutions are available to students.

The following degrees are offered by the University:

1. A student in the Ph.D. in Oceano-



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graphy program will, after admission to graduate study, consult the Faculty Advisor of his major concerning appointment of his advisory committee. This committee will consist of not less than five members of the Graduate Faculty representative of the student's several fields of study and research; two of the members must be from disciplines outside the major field.

The committee will evaluate the student's previous training and degree objectives. They will then outline a degree program and research problem which, with the dissertation, will constitute the basic requirements for the degree. The field of study may be chiefly in one department or may be in a combination of departments.

To qualify for the preliminary examination, the student must have satisfied the language requirements and have completed all but approximately six hours of the formal course work on the Degree Program, excluding 691 (Dissertation Research). The examination shall be both oral and written unless otherwise recommended by the student's committee and the Graduate Council Representative and approved by the Dean of the Graduate College. The written part of the examination will cover each field of study included in the student's program and both parts of the examination must be completed within a length of time approved by the Dean of the Graduate College, usually not exceeding two weeks. Credit for the preliminary examination is not transferable.

The general field of research to be used for the dissertation should be agreed on by the student and his committee at their first meeting, as a basis for selecting the proper courses to support the proposed research.

2. In the M.S. in Oceanography program, the student's committee, in consultation with the student, will develop his Degree Program.

The student must prepare a thesis proposal for approval by his committee. This proposal must be submitted for the approval of the Dean of the Graduate College at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive his degree.

A minimum of two full semesters of approved courses and research (32 semester hours) is required for the Master of Science degree. Ordinarily the student will devote the major portion of this time to work in one field or two closely related fields. Other work will be in supporting fields of interest. In general, not less than one third of the course work, exclusive of research, should be taken in one or more fields outside the major field.

Specialization may be undertaken for both the M.S. and Ph.D. degrees in biological, chemical, geological, meteorological, and physical oceanography. It is also possible for certain students with undergraduate degrees in engineering to substitute engineering course work for up to 15 semester hours of prerequisites for the discipline in which advanced work is desired. Such a program usually consists of the regular physical oceanography program with a minor in engineering. Students may also enroll in pertinent courses offered in other departments, e.g., Geology and Geophysics, Biology, Mathematics, and Physics among others. An effort is made to maintain a balance between the biological, chemical, geological and physical aspects of oceanography both in teaching and research.

3. Ph.D. in Zoology, Microbiology, Botany, or Biology (Marine emphasis). All students are required to obtain practical research experience in areas of marine emphasis. Even though there are no absolute course requirements, each doctoral candidate is expected to complete at least 96 semester hours (research and formal courses) above a B.S. (B.A.) or 64 semester hours (research and formal courses) beyond an M.S. (M.A.). After the completion of the formal course requirement agreed upon by the student's committee, he must successfully pass an oral and written preliminary examination for admission to candidacy. To qualify for the preliminary examination, the candidate should have completed his language requirements and have submitted an approved research proposal. Following admission to candidacy, a suitable research problem must be completed and a dissertation presented to demonstrate his capability for independent research. Each student must satisfy one of the three optimal language requirements: a. mastery of one foreign language; b. reading knowledge of two foreign languages (demonstrated by making an acceptable grade on the Princeton examination); c. reading knowledge of one foreign language and six hours of course work not a part of a degree program and not related to degree objectives.

4. M.S. in Zoology, Microbiology, Botany, or Biology (Marine emphasis). All students who are candidates for an M.S. degree are required to obtain practical experience in some phase of marine biology and to demonstrate competence by satisfactorily completing a comprehensive examination and a thesis project. Each student is required to satisfactorily complete 32 hours of course work, eight of which will be credited for successfully completing an acceptable research thesis.

5. M.S. in Marine Resources Management (College of Business Administration). The wise development of our marine resources, including those in the coastal zone, requires men and women who possess not only an in-depth comprehension of the ecology of the coastal zone, but also managerial perspective and decision-making ability. The graduate curriculum leading to an M.S. degree in Marine Resources Management will facilitate the education of managers with the requisite knowledge, concepts, and skills. The curriculum consists of 36 hours of work, of which 15 hours is in business related fields, 15 hours in a supporting field such as oceanography, and the remaining 6 hours involving an internship and the writing of a thesis.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF OCEANOGRAPHY

| | | |
|---|---|---|
| 205 | Introduction to Ocean Studies | 1 |
| 401 | Introduction to Oceanography | 3 |
| 603 | Sea Laboratory Techniques | 1 |
| 608 | Physical Oceanography | 4 |
| 609 | Physical Oceanography | 3 |
| 611 | Theoretical Physical Oceanography | 3 |
| 612 | Elements of Ocean Wave Theory | 3 |

| | | |
|---|---|---|
| 614 | Dynamics of the Ocean and Atmosphere | 3 |
| 615 | Long Waves and Tides | 4 |
| 616 | Theory of Ocean Waves | 3 |
| 617 | Theories of Ocean Circulation | 3 |
| 618 | Underwater Sound | 3 |
| 620 | Biological Oceanography | 3 |
| 622 | Analysis of Benthic Communities | 3 |
| 623 | Marine Zooplankton | 3 |
| 624 | Marine Phytoplankton | 3 |
| 625 | Deep-Sea Pelagic and Demersal Fishes | 3 |
| 626 | Organic Cycles of the Sea | 3 |
| 630 | Geological Oceanography | 3 |
| 631 | Geological Oceanography | 3 |
| 633 | Carbonate Sediments I | 2 |
| 634 | Carbonate Sediments II | 3 |
| 635 | Techniques in Geological Oceanography | 4 |
| 638 | Simulation Techniques | 4 |
| 639 | Lithophycology | 3 |
| 640 | Chemical Oceanography | 3 |
| 641 | Chemical Oceanography | 3 |
| 643 | Geochemistry of the Ocean | 3 |
| 644 | Isotope Geochemistry | 3 |
| 651 | Meteorological Oceanography | 3 |
| 652 | Ocean Boundary Layer Problems | 3 |
| 653 | Synoptic Physical Oceanography | 3 |
| 681 | Seminar I | 1 |
| 682 | Seminar II | 1 |
| 685 | Problems | 1-4 |
| 691 | Research | 1-16 |

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 357 | Invertebrate Ecology | 4 |
| 435 | Advanced Invertebrate Zoology | 4 |
| 440 | Marine Biology | 4 |
| 457 | Bacterial Ecology | 4 |
| 481 | Seminar in Biology | 1 |
| 485 | Biological Problems | 1-4 |

GRADUATE COURSES

| | | |
|---|---|---|
| 608 | Phycology | 4 |
| 612 | Biology of Estuarine Organisms | 3 |
| 637 | Marine Botany | 4 |
| 653 | Zoogeography | 3 |
| 662 | Biology of the Mollusca | 4 |
| 663 | Biology of the Crustacea | 4 |
| 665 | Invertebrate Zoology | 4 |
| 668 | Biology of Invertebrate Symbioses | 4 |
| 681 | Seminar (Marine Topics) | 1 |
| 685 | Problems in Marine Biology | 1-4 |
| 691 | Research in Marine Biology | 1- or more |

MARINE LABORATORY

The following courses are offered at the Marine Laboratory in conjunction with various departmental programs (Biology, Oceanography, Wildlife Science and Veterinary Microbiology).

BIOLOGY

| | | |
|---|---|---|
| 435 | Marine Invertebrate Zoology | 4 |
| 440 | Marine Biology | 4 |
| 485 | Problems | 1-4 |
| 637 | Marine Botany | 4 |
| 662 | Biology of the Mollusca | 4 |
| 663 | Biology of the Crustacea | 4 |
| 665 | Marine Invertebrate Zoology | 4 |
| 685 | Problems | 1-4 |
| 691 | Research | 1-4 |

OCEANOGRAPHY

| | | |
|---|---|---|
| 623 | Marine Zooplankton | 3 |
| 624 | Marine Phytoplankton | 3 |
| 685 | Problems | 1-4 |
| 691 | Research | 1-4 |

STATISTICS INSTITUTE

| | | |
|---|---|---|
| 406 | Statistical Methods | 3 |

WILDLIFE SCIENCE

| | | |
|---|---|---|
| 312 | Marine Ichthyology | 3 |
| 400 | Fisheries Survey | 4 |
| 418 | Animal Population Dynamics | 3 |
| 485 | Problems | 1-3 |
| 611 | Estuarine Ecology | 4 |
| 615 | Mariculture | 4 |
| 685 | Problems | 2-6 |
| 691 | Research | 1-4 |

VETERINARY MICROBIOLOGY

| | | |
|---|---|---|
| 660 | Diseases of Marine Invertebrates | 4 |

COLLEGE OF BUSINESS ADMINISTRATION

| | | |
|---|---|---|
| Acc | Natural Resource Accounting | 3 |
| Fin 670 | Planning, Programing, Budgeting Systems | 3 |
| Mgt 660 | Marine Resources Management | 3 |
| Mgt 661 | Marine and Coastal Zone Law | 3 |
| Mkt 649 | Marketing Management | 3 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF OCEANOGRAPHY

*Aldrich, David V., Ph.D., Associate Professor of Biological Oceanography
Berner, Leo, Jr., Ph.D., Associate Professor of Biological Oceanography
Bouma, Arnold H., Ph.D., Professor of Geological Oceanography
Bright, Thomas J., Ph.D., Assistant Professor of Biological Oceanography
Bryant, William R., Ph.D., Associate Professor of Geological Oceanography
Capurro, Luis R.A., D.Sc., Lecturer Physical Oceanography
Caruthers, Jerald W., Ph.D., Assistant Professor of Physical Oceanography
Clayton, William H., Ph.D., Professor of Physical Oceanography
Cochrane, John D., M.S., Associate Professor of Physical Oceanography
Darnell, Rezneat M., Ph.D., Professor of Biological Oceanography
El-Sayed, Sayed Z., Ph.D., Associate Professor of Biological Oceanography
Fahlquist, Davis A., Ph.D., Associate Professor of Geophysics
Geyer, Richard A., Ph.D., Professor and Head of the Department
Ichiye, Takashi, D.Sc., Professor of Physical Oceanography
Jeffrey, Lela M., Ph.D., Assistant Professor of Chemical Oceanography
Nowlin, Worth D., Jr., Ph.D., Associate Professor of Physical Oceanography
*Park, Tai Soo, Ph.D., Assistant Professor of Biological Oceanography

Pequegnat, Willis E., Ph.D., Professor of Biological Oceanography
Poag, C. Wylie, Ph.D., Assistant Professor of Geological Oceanography
Presley, Billy J., Ph.D., Assistant Professor of Chemical Oceanography
*Ray, Sammy M., Ph.D., Professor of Biological Oceanography and Director of the A&M Marine Laboratory
Reid, Robert O., M.S., Professor of Physical Oceanography
Rezak, Richard, Ph.D., Associate Professor of Geological Oceanography
Sackett, William M., Ph.D., Professor of Chemical Oceanography
Vastano, Andrew C., Ph.D., Associate Professor of Physical Oceanography
*Wilson, William B., Ph.D., Associate Professor of Biological Oceanography

*Located at the A&M Marine Laboratory in Galveston, Texas.

DEPARTMENT OF BIOLOGY

Anderson, Jack W., Ph.D., Assistant Professor
Cox, Elenor R., Ph.D., Assistant Professor
Dillon, Lawrence S., Ph.D., Professor
Harry, Harold W., Ph.D., Associate Professor
Hopkins, Sewell H., Ph.D., Professor
Horvath, Kalman, Ph.D., Assistant Professor
Kleerekoper, Herman, Ph.D., Professor
Kuchnow, Karl, Ph.D., Assistant Professor
Ray, Sammy M., Ph.D., Professor
Sweet, Merrill H., Ph.D., Associate Professor
Taber, Willard A., Ph.D., Professor
Wiebe, John, Ph.D., Assistant Professor
Wilson, William B., Ph.D., Associate Professor

MARINE LABORATORY

RESIDENT FACULTY

Aldrich, David V., Ph.D., Associate Professor of Biological Oceanography and Wildlife Science
Park, Tai Soo, Ph.D., Assistant Professor of Biological Oceanography
Ray, Sammy M., Ph.D., Professor of Biology and Biological Oceanography and Director of Marine Laboratory
Wilson, William B., Ph.D., Associate Professor of Biology and Biological Oceanography

VISITING FACULTY

Anderson, J. W., Ph.D., Assistant Professor of Biology
Berner, Leo, Jr., Ph.D., Associate Professor of Biological Oceanography
Berry, Richard J., Ph.D., Supervisory Fishery Biologist (Research), National Marine Fisheries Service (Galveston) and Assistant Professor of Wildlife Service
Chin, Edward, Ph.D., Associate Director, Institute of Natural Resources, University of Georgia, and Lecturer in Marine Biology
Cox, Elenor R., Ph.D., Assistant Professor of Biology
El-Sayed, Sayed Z., Ph.D., Associate Professor of Biological Oceanography
Freund, Rudolf J., Ph.D., Professor of Statistics and Economics
Horvath, Kalman, Ph.D., Assistant Professor of Biology
Moore, Donald, B.S., Fishery Biologist (Research), National Marine Fisheries Service (Galveston) and Instructor in Wildlife Science
Sparks, Albert K., Ph.D., Director, National Marine Fisheries Service (Galveston) and Professor of Veterinary Microbiology

To obtain further information, address all inquiries directly to:

Dr. Richard A. Geyer
Head, Department of Oceanography
Texas A&M University
College Station, Texas 77843

Dr. George M. Krise
Administrative Officer
Department of Biology
Texas A&M University
College Station, Texas 77843

Director, Marine Laboratory
Texas A&M University
Building 311, Fort Crockett
Galveston, Texas 77550

## TEXAS CHRISTIAN UNIVERSITY
### FORT WORTH, TEXAS

In 1970 the University completed construction of a new physical sciences building including modern laboratory facilities for Geology, Chemistry, and Physics. The completion date for the complete remodeling of the old science building is expected to be sometime in January 1971. The renovated science building will house the departments of Biology, Psychology, and Mathematics.

Several large laboratories have been designated for marine oriented research and include four large seawater systems. Facilities are well equipped for systematic, ecological, chemical and physiological marine studies. Studies of rivers, estuaries and shallow-water marine habitats are emphasized.

M.S. degrees are offered in Biology, Environmental Science, and Geology with emphasis on marine problems. Most marine research is carried out in the environmental sciences program. This program is an interdisciplinary one between the departments of Biology and Geology.

M.S. in Environmental Science. All students must complete four graduate core courses: Geology 6213, Geology 5243, Biology 6513, and Biology 5723. Nine hours of electives may be chosen from Biology, Geology, or approved by the environmental sciences committee. Three hours of seminar and six hours of thesis must also be completed. Regardless of prior major discipline, the student should have a minimum of one year each of Biology and Chemistry and one course in Physical Geology. Students who do not have credit must complete at least one course in calculus and one in metropolitan and regional planning prior to completion of the degree.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 3104 | Invertebrate Zoology | 4 |
| 3203 | Ecology | 3 |

| | | |
|---|---|---|
| 5713 | Marine Ecology | 3 |
| 5723 | Aquatic Biology | 3 |
| 6103 | Invertebrate Morphology and Physiology | 3 |
| 6302 | Principles of Taxonomy | 2 |
| 6313 | Advanced Invertebrate Zoology | 3 |
| 6503 | Fishery Biology | 3 |
| 6513 | Field Techniques in Environmental Biology | 3 |
| 7900 | Thesis Research | 6 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 3123 | Descriptive Oceanography | 3 |
| 3313 | Invertebrate Paleontology | 3 |
| 3323 | Invertebrate Paleontology | 3 |
| 5243 | Geochemistry of Natural Waters | 3 |
| 5313 | Micropaleontology | 3 |
| 5513 | Sedimentation | 3 |
| 6213 | Instrumental Analysis | 3 |
| 6323 | Principles of Paleoecology | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Blanton, William G., Ph.D., Adjunct Professor
Britton, Joseph C., Jr., Ph.D., Assistant Professor
Couch, Ernest F., Ph.D., Assistant Professor
Forsyth, John, Ph.D., Professor
Hewatt, Willis G., Ph.D., Professor
Keith, Donald E., Ph.D., Assistant Professor
Lyles, Sanders T., Ph.D., Professor
Murphy, Clifford E., Ph.D., Professor
Newland, Leo G., Ph.D., Assistant Professor
Smith, J. Durward, Ph.D., Chairman and Associate Professor

DEPARTMENT OF GEOLOGY

Ehlmann, Arthur J., Ph.D., Professor
Rowett, Charles L., Ph.D., Assistant Professor
Steinmetz, Richard, Ph.D., Assistant Professor
Walper, Jack L., Ph.D., Associate Professor

To obtain further information, address all inquiries directly to:

Dr. Donald E. Keith
Director, Environmental Sciences Program
Department of Biology
Texas Christian University
Fort Worth, Texas 76129

## UNIVERSITY OF TEXAS AT ARLINGTON
ARLINGTON, TEXAS

The University offers courses related to marine science at its campus in Arlington. With the completion of the new Life Science building, the University has modern and well equipped laboratory facilities in biology, geology, chemistry and physics in the School of Science. In addition, the School of Engineering maintains excellent laboratory facilities in such fields as civil, electrical, mechanical and industrial engineering.

A data processing center is located on campus and is available for all types of research activities.

The M.A. in biology, chemistry and physics and M.S. in geology with work concentrated in fields related to marine sciences are offered. Eighteen to 24 hours, inclusive of the thesis shall be in the major area of instruction (either in the field of concentration or in supporting courses within the major department). The remaining six to 12 hours shall be in a supporting subject or subjects outside the major area.

The following courses are offered in conjunction with the above program:

UNDERGRADUATE COURSES*

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 4348 | Aquatic Biology | 3 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 3341 | Invertebrate Paleontology | 3 |
| 3342 | Vertebrate Paleontology | 3 |
| 4343 | Sedimentation | 3 |

GRADUATE COURSES

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 5342 | Ichthyology | 3 |
| 5348 | Aquatic Microbiology | 3 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 5341 | Micropaleontology | 3 |
| 5345 | Paleoecology | 3 |
| 5344 | Sedimentary Petrography | 3 |

*Graduate credit may be granted for these courses.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Bo[illegible] Robert B., Ph.D., Associate [illegible]essor of Biology
He[illegible]ier, Thomas R., Jr., Ph.D., Associate Professor of Biology

DEPARTMENT OF GEOLOGY

Dodge, Charles F., Ph.D., Professor of Geology
McNulty, Charles L., Ph.D., Professor of Geology
Scott, Robert W., Ph.D., Assistant Professor of Geology

To obtain further information, address all inquiries directly to:

Dr. Peter R. Girardot
Dean of the School of Science
University of Texas at Arlington
Arlington, Texas 76010

## THE UNIVERSITY OF TEXAS
AUSTIN, TEXAS

The University offers courses in the marine sciences at both its main campus at Austin and its Marine Science Institute at Port Aransas, Texas. Research facilities on the 61-acre site of the Institute at Port Aransas

include: 20,000 square feet of research, biological collection, library, and shop space. Most of this is air-conditioned. A laboratory with running seawater is located on a pier over the Aransas Pass inlet. There is a special air-conditioned vibration-free laboratory. Twenty concrete and fiberglass experimental ponds are located on the grounds. A variety of small boats, an air-boat and a 40-foot self-propelled barge are available, as well as the 44-foot LORENE, a trawler used in securing specimens. A new 80-foot research vessel will be in operatiom by summer, 1971. The Institute's boat basin is located adjacent to the laboratory buildings at the Aransas Pass ship channel.

Master of Arts and Doctor of Philosophy programs in biological, physical, or earth sciences may be concentrated in the area of marine science. Marine science courses listed in the offerings of the various Main University science departments may be used as supporting work for programs in these or other science departments where they are pertinent.

1. M.A. in botany, chemistry, geology, microbiology, physics, zoology or engineering with work concentrated in marine science. Nine to 12 hours of marine science as the minor may be combined with 12 to 15 hours of the major and 6 hours of thesis registration for a total of 30 hours. There is no language requirement for the Masters degree in most of the related departments except Geology. The program of study and the thesis are approved by a supervisory committee appointed by the dean.

2. Ph.D. in botany, chemistry, geology, microbiology, physics, zoology, or engineering with work concentrated in marine science. General Marine Science, Mn.S. 680, and the Principles of Marine Science, Mn.S. 382, are recommended as given in summers at Port Aransas along with courses in the major and supporting areas in Austin as designated by the supervising committee. Requirements and examinations for admission to candidacy vary according to the specifications of the Graduate Faculty of the Major Department of Austin as indicated in the Graduate Catalogue of the Main University. German, French or Russian is generally used to fulfill the language requirement of the Graduate School. A second language is part of the degree requirements of the major in most of the related science departments. There is no set number of course hours required. The program of study, languages, final oral exam and doctoral dissertation are approved by the supervisory committee and the Dean.

Courses in the marine sciences are offered during the regular long sessions at the Austin campus by the departments of Zoology, Geography, Civil Engineering, Meteorology, and Geology. The Marine Science Institute also offers regular summer courses and thesis research or special problems courses all year long at Port Aransas.

Courses Offered at Port Aransas

| | | |
|---|---|---|
| 382.1 | Marine Invertebrates | 3 |
| 382.2* | General Marine Microbiology | 3 |
| 382.3* | Marine Geology | 3 |
| 382.4 | Marine Botany | 3 |
| 382.51 | Marine Invertebrates | 3 |
| 382.52 | Marine Ichthyology | 3 |
| 382.53* | Ecology of Fishes | 3 |
| 382.6 | Marine Chemistry | 3 |
| 382.7* | Structure and Functions of Marine Animals | 3 |
| 382.8* | Estuarine Ecology | 3 |
| 341° | General Marine Science | 3 |
| 481 | Biological Oceanography and Marine Ecology | 4 |
| 680 | Research in Marine Science | 6 |
| 680.1 | Biological Oceanography, Marine Ecology, Limnology | 6 |
| 680.2 | General Marine Microbiology | 6 |
| 680.3 | Marine Geology | 6 |
| 680.4 | Marine Botany | 6 |
| 680.5 | Ecology of Fishes | 6 |
| 680.6 | Marine Chemistry | 6 |
| 680.7 | Structure and Function of Marine Animals | 6 |
| 680.9 | Endocrinology of Marine Organisms | 6 |
| 690 | General Marine Science | 6 |
| 698 | Thesis | 6 |
| 699 | Dissertation | 6 |

* Offered as 342. series for advanced undergraduates.

° Undergraduate Course

Courses Offered at Austin Campus

(Excluding courses such as special problems, conference, dissertation, thesis, and seminar courses that may deal with marine sciences)

| | |
|---|---|
| 241 | Environmental Health Engineering (Dept. of Civil Engineering) |
| 342 | Water Supply and Waste Water Disposal (Dept. of Civil Engineering) |
| 364 | Oceanography (Dept. of Geography) |
| 376 | Physical Oceanography (Dept. of Meteorology) |
| 391.2 | Marine Geology (Dept. of Geology) |
| 391.2 | Oceanography & Limnology (Dept. of Geology) |
| 391.52 | Sedimentary Geochemistry (Dept. of Geology) |
| 400 | Limnology and Oceanography (Dept. of Zoology) |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BOTANY

Van Baalen, C., Ph.D., Associate Professor of Botany

DEPARTMENT OF CHEMISTRY

Parker, P. L., Ph.D., Associate Professor of Chemistry

DEPARTMENT OF GEOLOGY

Behrens, E. W., Ph.D., Assistant Professor of Geology

DEPARTMENT OF MICROBIOLOGY

Oppenheimer, Carl H., Ph.D., Professor of Microbiology

DEPARTMENT OF ZOOLOGY

Nicol, J. A. C., D.Sc., Professor of Zoology

Sage, Martin, Ph.D., Associate Professor of Zoology
Wohlschlag, Donald E., Ph.D., Professor of Zoology

To obtain further information, address all inquiries directly to:

Director
The University of Texas
Marine Science Institute
Port Aransas, Texas 78373

## UNITED STATES COAST GUARD ACADEMY
### NEW LONDON, CONNECTICUT

Ocean Science courses are offered under the Department of Physical and Ocean Sciences. Complete laboratory facilities are available in the general chemistry laboratories as well as our specialized laboratory devoted strictly to oceanography. Special facilities available for class and individual use include wave tanks, refrigerated aquariums, estuarine models, a weather satellite receiver, and a completely equipped fleet of small craft for oceanographic studies of Long Island Sound and adjacent waters. An IBM 1620 and a GE 225 computer are used in most of the Ocean Science courses and research projects being carried out. Summer programs utilize the large oceanographic vessels of the Coast Guard for high sea and polar expeditions. In addition, shore based oceanographic installations are made available to students for both training and research project usage.

The Bachelor of Science is offered. Those students who select Oceanography as a study option complete a basic pre-science-engineering background program which includes five semesters of Math, three semesters of Physics two semesters of Chemistry, Mechanics, Thermodynamics, Fluid Mechanics and Electrical Science. In addition, starting with the spring semester of their sophomore year, they commence on a program of eight required oceanography courses plus the possibility of taking additional oceanography electives.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| 5218 | Introduction to Marine Biology/Geology | 4 |
| 5301 | Oceanography I | 3.5 |
| 5321 | Physical Oceanography | 4 |
| 5323 | Biological Oceanography | 4 |
| 5326 | Meteorology | 4 |
| 5420 | Waves and Tides | 3.5 |
| 5422 | Regional Oceanography | 4 |
| 5423 | Estuarine Circulation and Pollution | 4 |
| 5424 | Air/Sea Interaction | 4 |
| 5426 | Chemical Oceanography | 4 |
| 5427 | Marine Fisheries | 3 |
| 5428 | Observation Survey Techniques | 3 |

The instructional staff for the courses listed above consists of the following:

Costello, Hugh J., M.A.L.S., Associate Professor of Chemistry/Oceanography
Lissauer, Ivan M., LT, USCG, B.S., Instructor of Oceanography/Meteorology
Kollmeyer, Ronald C., CDR, USCG, M.S., Head, Ocean Science Section and Associate Professor of Oceanography
McGill, David A., Ph.D., Professor of Oceanography
Nagel, Harold A., M.S., Assistant Professor of Oceanography/Meteorology
Tolderlund, Douglas S., Ph.D., Assistant Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dean of Academics
U.S. Coast Guard Academy
New London, Connecticut 06320

## GRADUATE SCHOOL
## U.S. DEPARTMENT OF AGRICULTURE
### WASHINGTON, D. C.

A Certified Statement of Accomplishment in Oceanography is granted to a student who has completed an organized program of courses in the field. The requirements for this Certified Statement are 20 semester hours of credit with a grade of C or better in each of the following courses:

a. Required courses (6 credits):

| | |
|---|---|
| Biological Oceanography | 2 |
| Geological Oceanography | 3 |
| Physical Properties of Sea Water | 2 |

b. Electives (7 credits):

| | |
|---|---|
| Applied Underwater Sound | 2 |
| Biological Oceanography | 2 |
| Chemical Oceanography | 2 |
| Dynamic Oceanography | 2 |
| Marine Geophysics | 2 |
| Marine Meteorology | 2 |
| Ocean Engineering | 3 |
| Oceanographic Remote Sensing | 2 |
| Ocean Surface Waves | 2 |
| Physics of Marine Atmosphere | 2 |
| Practical Electronics for Biologists and Chemists | 4 |
| Principles of Underwater Sound | 2 |

c. 6 semester hours of credit in fields related to oceanography, including biology, chemistry, engineering, geography, geology, mathematics, and meteorology.

A student seeking this certified statement should consult with the Registrar and obtain approval of his proposed course of study early in his academic program. Equivalent courses will be accepted by transfer from other institutions. An applicant for this certified statement must file a transcript of his high school or college record before completion of this program.

The following courses are offered in conjunction with the school program:

| | | |
|---|---|---|
| 5-360 | General Oceanography | 2 |
| 5-409 | Piloting and Electronics Navigation | 3 |
| 5-414 | Celestial Navigation | 3 |
| 5-475 | Principles of Underwater Sound | 2 |
| 5-476 | Applied Underwater Sound | 2 |
| 5-584 | Physical Properties of Sea Water | 2 |
| 5-655 | Ocean Surface Waves | 2 |
| 5-549 | Chemical Oceanography | 2 |
| 5-658 | Geological Oceanography | 3 |
| 5-546 | Physics of Marine Atmosphere | 2 |
| 5-520 | Marine Geophysics | 2 |
| 5-662 | Marine Meteorology | 2 |
| 5-706 | Ocean Engineering | 3 |
| 5-429 | Oceanographic Remote Sensing | 2 |
| 5-664 | Dynamic Oceanography | 2 |
| 5-666 | Biological Oceanography | 2 |

The instructional staff for the courses listed above consists of the following:

Ackerman, Karl H., Navigational Scientist, U. S. Naval Oceanographic Office
Andersen, Neil R., Head, Marine Radioisotopes Branch, U. S. Naval Oceanographic Office
Anderson, Rochne S., Oceanographer, U. S. Naval Oceanographic Office
Burkhart, M.D., Scientific Staff Assistant, Office of the Oceanographer of the Navy
Cuzon du Rest, Rene P., Senior Biological Oceanographer, National Oceanographic Data Center
Gilcrest, Robert A., Physical Oceanographer, U. S. Naval Oceanographic Office
Loomis, P. Burr, Oceanographer, U. S. Naval Oceanographic Office
Noble, Vincent E., Physicist, U. S. Naval Oceanographic Office
Paulus, William C., Oceanographer-Instructor, U. S. Naval Oceanographic Office
Peloquin, Robert A., Physical Oceanographer, U. S. Naval Oceanographic Office
Picciolo, Anthony R., Head, Data Applications Branch, National Oceanographic Data Center
Schule, John J., Jr., Director, Research and Development, U. S. Naval Oceanographic Office
Weiss, Martin, Oceanographer, National Oceanographic Data Center
Winokur, Robert S., Acting Division Director, Exploratory Oceanography Division, U. S. Naval Oceanographic Office

To obtain further information, address all inquiries directly to:

The Registrar
Graduate School
U.S. Department of Agriculture
Washington, D.C. 20250

## UNITED STATES NAVAL ACADEMY
### ANNAPOLIS, MARYLAND

Commencing in 1963, major or minor degrees specified in oceanography were established and in July 1970, the Department of Environmental Sciences was established containing the disciplines of oceanography, meteorology, geology, and biology. Departmental offices, classrooms and laboratories are located in Chauvenet Hall, completed in 1968. Specialized Laboratories include those in general and advanced oceanography, meteorology, biology, environmental instruments, geology and biology, each containing specialized support equipment. A semi-automatic weather station, a climatological station, and a wave tank are used for midshipmen instruction. Dockside laboratory facilities are under construction on the Severn River to support an 88-foot 67-ton Yard Patrol craft, instrumented for oceanographic data collection. Computer support facilities, for midshipmen instruction, include the IBM 1620 and the GE 650 computers.

The B.S. Degree with a specified major in Oceanography is offered. The Naval Academy is a mission oriented school, designed to produce career, professional officers for the Naval Service. Midshipmen receive over 50 semester hours of professional education in the fields of seamanship, tactics, navigation, engineering, weaponry, history, law, and leadership. Additionally, Naval Academy midshipmen receive a broad liberal arts education in mathematics, social science and humanities.

The program is primarily oriented toward achievement in the area of Physical Oceanography and Meteorology. Midshipmen majoring in oceanography must complete Mathematics through Differential Equations, Chemistry, Physics, Biology, Geology, Thermodynamics, and Fluid Dynamics. The basic course sequence within the major includes General Meteorology, General Oceanography, Environmental Dynamics and Naval Oceanographic Applications. Additionally, a midshipman must complete three elective courses from within those offered in the department or from course offerings, acceptable to the Department Chairman, given in the Mathematics, Physics, Chemistry or Engineering Departments.

The following courses are offered in conjunction with the above program:

DEPARTMENT OF ENVIRONMENTAL SCIENCES

| | | |
|---|---|---|
| SB151 | General Biology I | 4 |
| SB152 | General Biology II | 4 |
| SG161 | Physical Geology | 4 |
| SG162 | Historical Geology | 3 |
| SO111 | Air/Ocean Environment | 3 |
| SO212 | General Oceanography | 4 |
| SO221 | Introduction to Oceanography | 3 |
| SO241 | General Meteorology | 3 |
| SO312 | Environmental Dynamics | 3 |
| SO411 | Naval Oceanographic Applications | 4 |
| SO412 | Environmental Instruments | 3 |
| SO415 | Environmental Pollution | 3 |
| SO421 | Ocean Waves and Tides | 3 |
| SO422 | Nearshore Oceanography | 3 |
| SO423 | Physical Oceanography | 3 |
| SO441 | Synoptic Meteorology | 3 |
| SO442 | Tropical Meteorology | 3 |
| SO443 | Physical Meteorology | 3 |
| SO444 | Climatology | 3 |
| SO451 | Biological Oceanography | 3 |
| SO461 | Geological Oceanography | 3 |
| SO471 | Chemical Oceanography | 3 |
| SO491 | Oceanography Research Project | 3 |

The instructional staff for the courses listed above consists of the following:

Anderson, Richard O., LCDR, USN, B.S., Instructor in Oceanography
Birchett, John A.K. III, LCDR, USN, M.S., Instructor in Oceanography
Brown, Dale S., Jr., LCDR, USN, B.S., Instructor in Oceanography
Corey, R. Reese, Jr., Ph.D., Professor in Biology
Edsall, Douglas W., M.S., Assistant Professor in Geology
Gatje, Peter H., LCDR, USN, M.S., Instructor in Meteorology
Glancy, Thomas J. Jr., CDR, USN, M.A., Chairman and Instructor in Oceanography
Johnson, Harry N., MAJ, USMC, Ph.D., Instructor in Biology
Hendrix, Charles N.G., CAPT, USN (RET), M.S., Associate Professor in Oceanography
Hoffman, John F., M.S., Associate Professor in Oceanography
Mullarky, Jon I., LCDR, USN, M.S., Instructor in Geology
Schramm, William G., LCDR, USN, M.S., Instructor in Meteorology
Siegel, Kent R., LCDR, USN, B.S., Instruc-

tor in Geology
Smith, John A., LCDR, USN, M.S., Instructor in Oceanography
Williams, Jerome, M.A., Associate Chairman and Associate Professor of Oceanography

To obtain further information, address all inquiries directly to:

Academic Dean
U.S. Naval Academy
Annapolis, Maryland 21402

## VIRGINIA INSTITUTE OF MARINE SCIENCE
### GLOUCESTER POINT, VIRGINIA

The Institute is located on the York River 30 miles from the mouth of the Chesapeake Bay. A second campus at Wachapreague on seaside of Virginia's Eastern Shore provides access to the barrier beaches, lagoons, and marshes of the Atlantic Coast. Facilities include modern permanent laboratory buildings, a research fleet with regular cruises over the continental shelf and a year-round research program.

All classwork and graduate study is directed by working scientists in the environment of an active marine research program. Modern laboratory and field instruments are available. An electron microscope has recently been added to the laboratory equipment inventory.

Research is being carried on in marine ecology, physiology of marine organisms, pollution problems, microbiology, radiobiology, diseases of shellfish, fish life histories, fishery biology, chemical oceanography, marine geology, meteorology, physical oceanography and parasitology.

The Institute offers the degrees of Master of Arts and Doctor of Philosophy in Marine Science through the School of Marine Science, College of William and Mary, Williamsburg, Virginia and the degrees of Master of Arts and Doctor of Philosophy in Marine Science through the Department of Marine Science, University of Virginia, Charlottesville Virginia, all with majors in Biological Oceanography, General Oceanography and Fisheries Biology.

The following courses are offered in conjunction with the above program. These courses are also offered under different numbers by the Department of Marine Science, University of Virginia.

| | | |
|---|---|---|
| 401 | Introduction to Physical Oceanography | 3 |
| 402 | Introduction to Chemical Oceanography | 3 |
| 403 | Introduction to Biological Oceanography | 3 |
| 404 | Introduction to Geological Oceanography | 3 |
| 405 | Problems in Marine Science | 1-4 |
| 406 | Introduction to Marine Science | 5 |
| 407 | Biometry I | 4 |
| 410 | Marine and Freshwater Invertebrates | 5 |
| 412 | Marine Botany | 5 |
| 419 | Computer Applications in Marine Science | 1 |
| 420 | Workshop in Scientific Writing | 1 |
| 501 | Marine Science Seminar | 1-3 |
| 502 | Advanced Biological Oceanography | 3 |
| 503 | Advanced Problems in Marine Science | 1-4 |
| 504 | Biology of Selected Marine Invertebrates | 3 |
| 505 | Radiobiology | 5 |
| 507 | Marine Microbiology | 5 |
| 508 | Ichthyology | 5 |
| 510 | Pollution Biology | 5 |
| 511 | Geological Oceanography | 3 |
| 512 | Parasites of Marine Organisms | 5 |
| 513 | Marine Biogeography | 3 |
| 514 | Littoral Processes | 4 |
| 515 | Embryology of Marine Invertebrates | 5 |
| 518 | Marine Fishery Science | 4 |
| 519 | Biometry II | 3 |
| 520 | Comparative Animal Physiology | 3 |
| 521 | Chemical Oceanography | 3 |
| 522 | Comparative Animal Physiology Laboratory | 2 |
| 524 | Physiology of Marine Organisms | 5 |
| 525 | Hydromechanics | 3 |
| 526 | Geophysical Fluid Dynamics | 3 |
| 527 | Physical Oceanography of Coastal Waters | 4 |
| 528 | Micrometeorology and Hydrology of the Coastal Zone | 3 |
| 529 | Mechanics of Sedimentation in Coastal Environments I | 4 |
| 530 | Mechanics of Sedimentation in Coastal Environments II | 4 |
| 531 | Estuary and Shallow Water Hydrodynamics I | 3 |
| 532 | Estuary and Shallow Water Hydronamics II | 3 |
| 533 | Oceanographic Remote Sensing | 3 |
| 540 | Population Dynamics | 4 |
| 541 | Advanced Techniques in Statistical Analysis | 1-3 |
| 544 | Marine Mycology | 4 |
| 545 | Marine Phytoplankton | 3 |
| 546 | Marine Zooplankton | 3 |
| 547 | Marine Benthos | 3 |
| 548 | Marine Protozoology | 4 |
| 560 | Thesis | |
| 660 | Dissertation | |

The instructional staff for the courses listed above consists of the following:

Andrews, Jay Donald, Ph.D., Professor of Marine Science
Black, Robert E. Lee, Ph.D., Professor of Biology and Marine Science
Brehmer, Morris Leroy, Ph.D., Professor of Marine Science
Hargis, William Jennings, Jr., Ph.D., Dean and Professor of Marine Science
Harrison, Wyman, Ph.D., Professor of Marine Science
Joseph, Edwin Bibb, Ph.D., Professor of Marine Science
Van Engel, Willard Abraham, Ph.B., Ph.M., Professor of Marine Science
Wood, Langille Wood, Ph.D., Professor of Marine Science
Bender, Michael E., Ph.D., Associate Professor of Marine Science
Byrne, Robert L., Ph.D., Associate Professor of Marine Science
Davis, William Jackson, Ph.D., Associate Professor of Marine Science
Haefner, Paul A., Jr., Ph.D., Associate Professor of Marine Science
Haven, Dexter Stearns, M.S., Associate Professor of Marine Science

Nichols, Maynard M., Ph.D., Associate Professor of Marine Science
Norcross, John Judson, M.S., Associate Professor of Marine Science
Wass, Marvin Leroy, Ph.D., Associate Professor of Marine Science
Zubkoff, Paul L., Ph.D., Associate Professor of Marine Science
Bailey, Robert Sydnor, M.S., Assistant Professor of Marine Science
Calder, Dale R., Ph.D., Assistant Professor of Marine Science
Chittenden, Mark E., Ph.D., Assistant Professor of Marine Science
DuPuy, John L., Ph.D., Assistant Professor of Marine Science
Fang, Ching Seng, Ph.D., Assistant Professor of Marine Science
Grant, George C., Ph.D., Assistant Professor of Marine Science
Hyer, Paul V., Ph.D., Assistant Professor of Marine Science
Kazama, Frederick Yoshio, Ph.D., Assistant Professor of Marine Science
Kuo, Albert Y., Ph.D., Assistant Professor of Marine Science
Loesch, Joseph, Ph.D., Assistant Professor of Marine Science
MacIntyre, William G., Ph.D., Assistant Professor of Marine Science
Munday, John C., Jr., Ph.D., Assistant Professor of Marine Science
Musick, John A., Ph.D., Assistant Professor of Marine Science
Ott, Franklyn D., Ph.D., Assistant Professor of Marine Science
Perkins, Frank Overton, Ph.D., Assistant Professor of Marine Science
Ruzecki, Paul Evon, M.S., Assistant Professor of Marine Science
Smith, Craig L., Ph.D., Assistant Professor of Marine Science
Webb, Kenneth Louis, Ph.D., Assistant Professor of Marine Science
Bolus, Robert L., M.S., Instructor in Marine Science
Merriner, John V., M.S., Instructor in Marine Science
Moncure, Richard W., B.S., Instructor in Marine Science
Warinner, Junius Ernest, III, M.A., Instructor in Marine Science
Wojcik, Frank John, M.S., Instructor in Marine Science
Zwerner, David Eric, M.A., Instructor in Marine Science

To obtain further information, address all inquiries directly to:

Dr. William J. Hargis, Jr.
Director
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

## WALLA WALLA COLLEGE
### COLLEGE PLACE, WASHINGTON

The College offers marine science courses at its Marine Station on Puget Sound near Anacortes. Supporting course work is offered on the main campus at College Place. Facilities for the maintenance and use of marine organisms in research are available in the Life Sciences Complex completed on the main campus in 1967. The Walla Walla College Marine Biological Station provides teaching and research laboratories serviced by a circulating water system. In addition the Marine Station operates two research vessels, the 40-foot NOCTILUCA, and the 43-foot E.S. BOOTH. A number of smaller boats are available for research work associated with the courses being offered.

The degree of M.A. in Biology with an emphasis in Marine Biology is offered in the Department of Biology.

All students must complete a minimum of 45 graduate approved credits, pass written and oral departmental examinations, and demonstrate ability to carry out independent research fulfilling the thesis requirement.

The following courses are offered in conjunction with the above program:

BIOLOGY DEPARTMENT

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 427 | Coastal Flora | 4 |
| 428 | Physiology of the Algae | 4 |
| 429 | Limnology | 4 |
| 451 | Invertebrate Zoology | 5 |
| 462 | Ichthyology | 4 |
| 463 | Marine Botany | 4 |
| 467 | Biological Oceanography | 4 |
| 468 | Comparative Physiology | 4 |
| 470 | BioPhysics | 4 |
| 474 | Marine Invertebrates | 4 |

GRADUATE COURSES

| | | |
|---|---|---|
| 510 | Graduate Seminar | 1 |
| 514 | Symbiosis | 4 |
| 525 | Readings in Animal Physiology | 2 |
| 526 | Readings in Invertebrate Zoology | 2 |
| 529 | Readings in Symbiosis | 2 |
| 530 | Readings in Plant Physiology | 2 |
| 545 | Thesis | 8 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY AND THE MARINE BIOLOGICAL STATION

Barnett, Claude C., Ph.D., Professor of Physics
Clayton, Dale L., Ph.D., Assistant Professor of Biology
Forss, Carl A., Ph.D., Associate Professor of Biology
Grable, Albert E., Ph.D., Associate Professor of Biology
McCloskey, Lawrence R., Ph.D., Assistant Professor of Biology
McNiel, Oran, M.S.E.E., Assistant Professor of Engineering and Director of Marine Biological Station
Perry, Alfred W., Ph.D., Associate Professor of Biology
Rigby, Donald W., Ph.D., Professor of Biology and Chairman, Department of Biology

To obtain further information, address all inquiries directly to:

Chairman, Department of Biology
Walla Walla College
College Place, Washington 99324

## WASHINGTON AND LEE UNIVERSITY
### LEXINGTON, VIRGINIA

The facilities of all the science departments are available to students majoring in Oceanography but since this is a small, undergraduate liberal arts school there are no

specialized facilities for marine sciences.

The B.S. in Geology (Marine Geology Emphasis) is offered by the University. Students with career interest in Oceanography may wish to take a B.S. degree in geology with special emphasis in interdisciplinary fields. The B.S. degree in geology requires the following courses:

Geology: 150, 210, 220, 310, 320, 321,330, 331, and 350 (31 credits)
Mathematics: 101 and 102 (Calculus)
Courses selected from biology, chemistry, mathematics (above 102, 118, Statistics is recommended), and physics totaling 16 credits.
Senior Thesis - Geology 385 (4) or Honors 396 (3 or 6)
Comprehensive Examination.

The following courses are required for interdiscilpinary majors. Courses that are strongly recommended for graduate preparation but not required for the degree are given in parentheses.

Oceanography (Marine Geology Emphasis):
Mathematics: 102 and (118)
Physics: 105 and 106
Chemistry: 122
Biology: 114 and (371)
Geology: 121, 122, (150), 201, 210, 220, 320, (321), 330, 331, 350, and 351

The following courses are offered in conjunction with the above program:

GEOLOGY DEPARTMENT

| | | |
|---|---|---|
| Geol 101 | General Geology | 4 |
| Geol 110 | General Geology Lectures | 3 |
| Geol 111 | General Geology Laboratory | 1 |
| Geol 120A | The Descent of Men | 1 |
| Geol 121A | The Origin of the Earth | 1 |
| Geol 122B | The Great Ice Age | 1 |
| Geol 130B | The Moon | 1 |
| Geol 135A | Meteorology | 1 |
| Geol 140 | Geological Considerations in Urban and Regional Planning | 1 |
| Geol 141 | Water Resources | 1 |
| Geol 142B | Oil and Gas Geology | 1 |
| Geol 143A | Man and Natural Resources | 1 |
| Geol 145B | Regional Geomorphology of the United States | 1 |
| Geol 150 | Field Methods and Appalachian Geology | 6 |
| Geol 201 | Oceanography | 3 |
| Geol 210 | Mineralogy | 3 |
| Geol 220 | Optical Mineralogy and X-Ray Power Diffraction Techniques | 3 |
| Geol 310 | Igneous and Metamorphic Petrology | 4 |
| Geol 320 | Paleontology and Evolution | 3 |
| Geol 321 | Invertebrate Fossils | 2 |
| Geol 330 | Sedimentation and Sedimentary Rocks | 3 |
| Geol 331 | Stratigraphy | 3 |
| Geol 350 | Structural Geology and Tectonics | 4 |
| Geol 351 | Geophysics | 3 |
| Ceol 360 | Seminar | 3 |
| Geol 385 | Senior Thesis-Research | 4 |
| Geol 396 | Senior Thesis (Honors) | 3 or 6 |

The instructional staff for the courses listed above consists of the following:

GEOLOGY DEPARTMENT

Kozak, Samuel J., Ph.D., Professor of Geology
McGuire, Odell S., Ph.D., Professor of Geology
Schwab, Fredric L., Ph.D., Assistant Professor of Geology
Spencer, Edgar W., Ph.D., Professor of Geology, Chairman

To obtain further information, address all inquiries directly to:

Dr. Edgar W. Spencer, Chairman
Geology Department
Washington and Lee University
Lexington, Virginia 24450

## UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON

The Department of Oceanography has laboratory and ship facilities located along the Lake Washington Ship Canal on the main campus. The Department occupies three permanent buildings (two of which were constructed in 1967 and 1968). Three research vessels ranging in size from 65 feet to 208 feet (the R/V HOH, R/V ONAR, and R/V THOMAS G. THOMPSON) are operated by the Department for inshore and deep-sea studies.

Special facilities include a closed salt-water system, controlled environment room, a tidal model of Puget Sound, wave tanks and rotating models, shipboard and shore-based IBM 1130 computers, a paleomagnetics laboratory, a sea-ice laboratory, X-ray emission and gamma-ray spectrometers, particle counters, provisions for work with radioactive isotopes, and a SCUBA support facility. Also available are an excellent fisheries-oceanography library, a well-equipped developmental laboratory, and the University Computer Center. Departmental teaching and research also use the University's Friday Harbor Laboratories, a marine biological station on San Juan Island, about 80 miles north of the main campus.

The following degrees are offered in the Department of Oceanography:

1. Bachelor of Arts. The student in the Bachelor of Arts curriculum must meet the requirements of the College of Arts and Sciences; choose a principal option and either two supporting options, or one supporting option and two minor options in Oceanography. All programs must include one option in physical oceanography. Courses can be substituted by Departmental permission.
2. Bachelor of Science. The Bachelor of Science curriculum is recommended for students who desire to complete a more intensive program than is required for the Bachelor of Arts. The student must meet the requirements of the College of Arts and Sciences; choose one principal option and three supporting options in Oceanography; and select ten or more credits of upper-division science or mathematics, with the guidance of an academic adviser.

Students who have majored in Oceanography or another science and appear likely to succeed in graduate study can be accepted in the program of the Department of Oceanography. Admission is based on grade records, letters of recommendation, and the results of the Graduate Record Examination. Students who have not majored in Oceanography should acquire a broad background in science and mathematics equivalent to the requirements for the bachelors degrees in Oceanography. Students with weak or narrow undergraduate preparation will probably take longer to earn a graduate degree. Additional information can

be obtained from the Graduate Program Office.

The student specializes in biological, chemical, geological, geophysical, or physical oceanography; interdisciplinary studies are possible. All requirements of the Graduate School must be satisfied.

3. Master of Science. The Department offers a thesis and a nonthesis program leading to the Master of Science degree. In both, the student and his adviser prepare a program of study to be approved by the student's Supervisory Committee. The program will include one principal option, two supporting options, and one minor option in Oceanography, and other courses in science and mathematics. A Departmental comprehensive written examination is required, and a reading knowledge of one foreign language, French, German, Japanese, or Russian, must be demonstrated. In the thesis program, a thesis approved by the Supervisory Committee must be prepared and presented at a seminar. The nonthesis program requires an approved research activity; the Supervisory Committee will decide whether written or oral reports are necessary.

4. Doctor of Philosophy. The student and his Supervisory Committee prepare a program of study and research. The program will include one principal option and three supporting options in oceanography, and other courses in science and mathematics. The student must pass a General Examination in oceanography and supporting fields. He then completes the research for his dissertation and prepares for his Final Examination.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

## DEPARTMENT OF OCEANOGRAPHY

### UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 101 | Survey of Oceanography | 5 |
| 109H | Survey of Oceanography-Honors | 5 |
| 110 | Lectures in Oceanography | 1 |
| 111 | Lectures in Oceanography | 1 |
| 112 | Lectures in Oceanography | 1 |
| 180H | Lower-Division Tutorial-Honors | 6 |
| 203 | Introduction to Oceanography | 5 |
| 280H | Introduction to Oceanography-Honors | 5 |
| 360 | Methods and Instruments in Oceanography | 3 |
| 380H | Upper-Division Tutorial-Honors | 6 |
| 385 | The Oceans I | 10 |
| 386 | The Oceans II | 10 |
| 388 | Oceanography for Science Teachers | 5 |
| 401 | General Physical Oceanography I | 5 |
| 402 | General Physical Oceanography II | 5 |
| 403 | General Biological Oceanography | 5 |
| 405 | General Geological Oceanography | 5 |
| 406 | Introduction to Geological Oceanography | 5 |
| 415 | Fundamentals of Underwater Acoustics | 3 |
| 416 | Applications of Underwater Acoustics | 2 |
| 417 | Physical Oceanography I | 5 |
| 418 | Physical Oceanography II | 5 |
| 419 | Ocean Tides and Waves | 5 |
| 421 | Chemical Oceanography | 2 |
| 422 | Chemical Oceanography | 2 |
| 423 | Chemical Oceanography Laboratory | 2 |
| 424 | Chemical Oceanography Laboratory | 2 |
| 433 | Biological Oceanography: Organisms and Processes | 3 |
| 434 | Biological Oceanography: Organisms and Environments | 3 |
| 435 | Biological Oceanography: Quantitative Aspects | 3 |
| 443 | Regional Oceanography | 2 |
| 444 | Design and Analysis of Oceanographic Experiments | 3 |
| 450 | Geological Oceanography | 5 |
| 452 | Physical Sedimentology | 5 |
| 454 | Biogenic Sediments I | 3 |
| 455 | Biogenic Sediments II | 3 |
| 456 | Acoustic and Seismic Techniques | 2 |
| 457 | Marine Sedimentation | 3 |
| 458 | Chemical Aspects of Marine Sediments | 5 |
| 460 | Field Experience in Oceanography | 1 |
| 461 | Field Experience in Oceanography | 1-5 |
| 462 | Applications of Oceanography | 3 |
| 480H | Undergraduate Research-Honors | 6 |
| 485 | Topics in Oceanography | 2 |
| 488H | Field Experience-Honors | 2-6, Max. 6 |
| 489H | Undergraduate Thesis-Honors | 1-6, Max. 6 |
| 499 | Undergraduate Research | 1-3, Max. 6 |

### GRADUATE COURSES

| | | |
|---|---|---|
| 505 | Current Problems in Geological Oceanography | 1 |
| 511 | Marine Hydrodynamics I | 4 |
| 512 | Marine Hydrodynamics II | 4 |
| 513 | Marine Hydrodynamics III | 4 |
| 514 | Seminar in Physical Oceanography | 1, Max. 9 |
| 515 | Waves | 4 |
| 516 | Ocean Circulation | 2 |
| 517 | Oceanography of Inshore Waters | 5 |
| 518 | Seminar in Dynamical Oceanography | 1, Max. 9 |
| 519 | Interaction of the Sea and Atmosphere | 5 |
| 520 | Seminar | 1, Max. 6 |
| 521 | Seminar in Chemical Oceanography | *, Max. 9 |
| 523 | Advanced Problems in Chemical Oceanography | 1-4, Max. 18 |
| 530 | Marine Primary Productivity | 3 |
| 531 | Seminar in Biological Oceanography | *, Max. 9 |
| 532 | Marine Microbiology | 1-4 |
| 533 | Zooplankton Ecology | 6 |
| 534 | Phytoplankton Ecology | 6 |
| 535 | Advanced Plankton Ecology | 3 |
| 536 | Benthos Ecology | 3 |
| 537 | Environmental Physiology of Marine Microalgae | 4 |
| 538 | Identification and Structure of Marine Benthic Communities | 2 |
| 540 | Seminar in Geometronics | 1-3 |
| 544 | Statistical Models in Oceanography | 3 |
| 548 | Topics in Physical Oceanography | 1-4, Max. 9 |
| 550 | Seminar in Geological Oceanography | *, Max. 9 |
| 551 | Marine Sediments | 2 |
| 553 | Research Techniques in | |

| | | |
|---|---|---|
| | Marine Geochemistry | 2 |
| 554 | Research Techniques in Marine Geology | 3 |
| 555 | Marine Geochemistry | 3 |
| 556 | Advanced Marine Geology | *, Max. 9 |
| 560 | Fluid Mechanics of Erosion and Sediment Transport | 3 |
| 561 | Seminar in Geological Fluid Mechanics | 3 |
| 571 | Gravity and Geomagnetic Interpretation | 3 |
| 573 | Terrestrial Magnetism | 3 |
| 581 | Analysis of Sediments and Sedimentary Rocks | 5 |
| 600 | Independent Study or Research | * |
| 700 | Thesis | * |
| 702 | Degree Final | 3 |
| 800 | Doctoral Dissertation | * |

*The amount of credit is variable.

In addition to the course offerings leading to the degrees mentioned, courses dealing with the ocean and of use to marine scientists are offered in the Departments of Botany, Geophysics, Atmospheric Sciences, Zoology, International Business, Geography, the College of Forest Resources, the Department of Economics, and the School of Law. The Division of Marine Resources coordinates the Sea Grant Program which involves courses related to marine resources taught in various departments and colleges.

The University also offers undergraduate and graduate programs in ocean engineering and fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF OCEANOGRAPHY

Aagaard, Knut, Ph.D., Research Assistant Professor
Anderson, George C., Ph.D., Research Professor
Banse, Karl, Ph.D., Professor
Barnes, Clifford A., Ph.D., Professor
Bennett, Lee C., Jr., Ph.D., Assistant Professor
Burns, Robert E., Ph.D., Senior Research Associate
Campbell, William, Ph.D., Affiliated Associate Professor
Cannon, Glenn A., Ph.D., Research Assistant Professor
Coachman, Lawrence K., Ph.D., Associate Professor
Creager, Joe S., Ph.D., Professor
Criminale, William O., Jr., Ph.D., Associate Professor
Dugdale, Richard C., Ph.D., Research Professor
Duxbury, Alyn C., Ph.D., Research Assistant Professor
Echols, Ronald J., Ph.D., Research Assistant Professor
English, T. Saunders, Ph.D., Associate Professor
Ewart, Terry E., Ph.D., Senior Research Associate
Fleming, Richard H., Ph.D., Professor
Fletcher, Joseph O., M.S., Research Professor
Frost, Bruce W., Ph.D., Assistant Professor
Halpern, David, Ph.D., Affiliate Assistant Professor
Healy, Michael L., Ph.D., Acting Assistant Professor
Henry, Dora P., Ph.D., Research Associate Professor
Kaczynski, Victor W., Ph.D., Assistant Professor
Kelley, James C., Ph.D., Assistant Professor
Larsen, Lawrence H., Ph.D., Research Assistant Professor
Lewin, Joyce C., Ph.D., Professor
Ling, Hsin-Yi, Ph.D., Research Associate Professor
Lister, Clive R. B., Ph.D., Assistant Professor
McManus, Dean A., Ph.D., Associate Professor
Martin, Seelye, Ph.D., Research Assistant Professor
Merrill, Ronald T., Ph.D., Assistant Professor
Murphy, Stanley, R., Ph.D., Professor
Pamatmat, Mario M., Ph.D., Senior Research Associate
Piper, David Z., Ph.D., Assistant Professor
Rattray, Maurice, Jr., Ph.D., Chairman and Professor
Richards, Francis A., Ph.D., Professor
Roden, Gunnar I., M.S., Senior Research Associate
Smith, J. Dungan, Ph.D., Assistant Professor
Sternberg, Richard W., Ph.D., Associate Professor
Taylor, Peter B., Ph.D., Assistant Professor
Winter, Donald F., Ph.D., Senior Research Associate
Worsley, Thomas, Ph.D., Senior Research Associate

To obtain further information, address all inquiries directly to:

Dr. William O. Criminale, Jr.
Acting Assistant Chairman for Instruction
22A Oceanography Teaching Building WB-10
Department of Oceanography
University of Washington
Seattle, Washington 98105

## UNIVERSITY OF WEST FLORIDA
PENSACOLA, FLORIDA

This new upper division state university, opened in 1967, offers Marine-Science-oriented courses on its 1000-acre main campus. Its present campus laboratory facilities, completed in 1967, are equipped for holding living marine specimens; and a new biology-chemistry laboratory is scheduled for occupancy in 1972. The University also shares facilities of the Bureau of Commercial Fisheries Field Station on Sabine Island located on Santa Rosa Island. To implement this University's commitment to the estuarine environment, its research vessel is the ARGONAUT, a 23-foot inboard-outdrive vessel, as well as smaller vessels, all of which are trailerable and especially equipped for estuarine study. Various vessels and cruisers of the State University System - Florida Institute of Oceanography - are used to give our students and faculty experience in the Gulf of Mexico.

The following degrees are offered by the University:

1. M.S. in Biology (Estuarine Studies). The Faculty of Biology offers the Master of Science degree although the program emphasizes estuarine studies. Many other areas of biology are also represented. All candidates for the Master of Science degree with thesis are required to complete a minimum of 45 quarter hours of catalogued credit. Of these, not less than 30 hours may be from By 500-By 690 courses, and not less than six or more than ten quarter hours may be from By 599 or By 699. Fifty percent of the total hours must be numbered 600 or above.

The matter of course selection is up to the student and his graduate advisory committee. If, upon review of the applicant's undergraduate record, a deficiency is noted by the student's graduate advisory committee, this deficiency must be remedied with a grade of "B" or better and without credit. As a rule, students may not select undergraduate courses from their previous major fields for graduate credit. However, with the advice or consent of their gradute advisory committee, students may cross their previous disciplinary lines and take up to 15 quarter hours of undergraduate course work from other fields in order to fill the 45 quarter hour graduate program minimum. A minimum of three quarters in academic residence is required.

In addition to course work, the student's program may require demonstration of a reading knowledge of scientific French, German, or Russian. A written thesis and oral defense must be completed in a manner satisfactory to the student's graduate advisory committee, and the thesis must conform to the standards for style set forth by the Graduate Program Committee of the Academic Council of the University of West Florida.

2. B.S. in Biology (Marine Sciences) Modern knowledge and application of biology and marine sciences requires a foundation in the physical and mathematical sciences. The prospective biologist or marine scientist should also have a well balanced general education in the humanities and social sciences. Consequently, the candidates for admission to the bachelor's degree program in biology at this University would be well prepared if they have completed credits in the following courses:

| | |
|---|---|
| Humanities (Including English Composition) | 14 |
| Social Sciences | 6 |
| Mathematics (through Trigonometry) | 6 |
| Chemistry (through Organic) | 16 |
| Physics (with laboratory) | 8 |
| Biology | 16 |

The curricular program for study with this faculty is based on a core of subject content common to the specialized study of all the areas within biology as a scientific discipline. The core courses are By 310, By 311, By 312, By 410, and By 411.

General Program Requirements: A student graduating from study with the Faculty of Biology will receive a B.S. degree in Biology when he has met the following departmental requirements: 1) An average of greater than 2.0 in all biology subjects taken. 2) Completion of the assigned biology core courses with no grade less than a C. 3) Completion of at least one academic term of general organic chemistry and statistics.

Marine Sciences: In addition to the core, the student must select an additional 20 hours of seminar and course work and at least three hours of directed study all involving a marine orientation.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

FACULTY OF BIOLOGY

| | | |
|---|---|---|
| 300 | Natural History of Marine Animals | 5 |
| 301 | Introduction to Oceanography | 5 |
| 310 | Molecular Biology | 6 |
| 311 | Genetics | 5 |
| 312 | Developmental Biology | 5 |
| 340 | Microbiology | 5 |
| 341 | Cell Biology | 5 |
| 343 | Principals of Evolution | 5 |
| 360-379 | Seminar | 1-5 |
| 410 | Environmental Biology | 6 |
| 411 | Organismic Biology | 6 |
| 440 | Marine Invertebrate Zoology | 5 |
| 441 | Marine Invertebrate Zoology | 5 |
| 444 | Marine Vertebrate Zoology (Laboratory) | 5 |
| 446 | Aquatic and Marine Botany | 5 |
| 499 | Directed Study | 1-5 |

SENIOR - GRADUATE COURSES

FACULTY OF BIOLOGY

| | | |
|---|---|---|
| 502 | Intermediary Metabolism | 5 |
| 520 | Estuarine Biochemistry | 5 |
| 521 | Estuarine Biology | 5 |
| 522 | Biological Oceanography | 5 |
| 530 | Plankton Biology | 5 |
| 531 | Biology of Algae | 5 |
| 550 | Development of Marine Invertebrates | 5 |
| 551 | Endocrinology of Marine Organisms | 5 |
| 560-579 | Senior Graduate Seminar | 1-5 |
| 599 | Directed Study | 1-3 |

GRADUATE COURSES

FACULTY OF BIOLOGY

| | | |
|---|---|---|
| 600 | Introduction to Ethology | 5 |
| 601 | Biology of Molluscs | 5 |
| 602 | Biology of Crustacea | 5 |
| 603 | Biology of Echinoderms | 5 |
| 604 | Protozoology | 5 |
| 606 | The Biology of Animal Parasites | 5 |
| 611 | Quantitative Ecology | 5 |
| 612 | Ecological Adaptations | 5 |
| 613 | Ecological Energetics | 5 |
| 623 | Aquatic and Marine Microbiology | 5 |
| 630 | Biology of Fishes | 5 |
| 640 | Biology of Vascular Plants | 4 |
| 645 | Aquaculture | 5 |
| 652 | Comparative Animal Physiology | 5 |
| 672-690 | Graduate Seminar | 1-5 |
| 699 | Thesis | 1-10 |

The instructional staff for the courses listed above consists of the following:

FACULTY OF BIOLOGY

Butler, Philip A., Ph.D., Faculty Associate of Biology
Chaet, Alfred B., Ph.D., Provost and Professor of Biology
Collard, Sneed B., Ph.D., Assistant Professor of Biology

D'Asaro, Charles N., Ph.D., Assistant Professor of Biology
Duke, Thomas W., Ph.D., Faculty Associate of Biology
Edmisten, Joe A., Ph.D., Associate Professor of Biology
Gifford, Charles A., Ph.D., Assistant Professor of Biology
Hopkins, Thomas S., Ph.D., Chairman and Associate Professor of Biology
Kerr, John P., Ph.D., Associate Professor of Biology
Moshiri, Gerald A., Ph.D., Assistant Professor of Biology
Riehm, John P., Ph.D., Associate Professor of Biology
Walsh, Gerald E., Ph.D., Faculty Associate of Biology

To obtain further information, address all inquiries directly to:

Dr. Alfred B. Chaet
Provost Gamma College and
Professor of Biology
The University of West Florida
Pensacola, Florida 32504

## WESTERN WASHINGTON STATE COLLEGE
### BELLINGHAM, WASHINGTON

The College has purchased a 71-acre marine laboratory site (Shannon Point) near Anacortes. The marine center, which is scheduled for completion in the summer of 1972, will emphasize undergraduate training in marine sciences.

Biology and Geology occupy separate floors of the Haggard Hall of Science. The two Departments share machine shop and electronic shop facilities for the construction and maintenance of instruments. A well-equipped computer center and an electron microscope laboratory are available for computer use.

Refrigerated salt water aquaria and several walk-in cold rooms are available for holding marine organisms in the Biology Department. For light dredging and trawling operations in protected waters, a 20-foot open work skiff equipped with a power winch is available.

The Institute for Fresh Water Studies, supported by the College, provides for student and faculty research activities in fresh and estuarine waters.

Besides present and future laboratory facilities, the Department of Geology has the use of a 32-foot charter boat. This boat is used for both instruction and research in the Puget Sound area. In addition, a great variety of coastal features are to be found within a short drive of the campus.

Huxley College, a cluster college, was formed in 1969 with the charge to fix its focus on the environment. The facilities will be temporary until the new Northwest Environmental Science Center building has been completed.

The following degrees are offered in the departments indicated:

The Biology Department offers programs for the B.A. and M.S. degrees in Biology. At the B.A. level, students take a core offering and may choose marine courses as part of the elective program. For the M.S., students are able to elect course work related to marine biology and may undertake thesis work in this area.

The B.A., B.S. and M.S. degrees in Geology with an emphasis in marine science are offered by the College. At the B.A. and B.S. level, students take a core offering and may choose marine courses as part of the elective program. At the M.S. level students are able to elect course work related to marine geology and may undertake thesis work in marine science. Course offerings in the geophysics concentration offered by the Department considerably enhance studies in marine geology.

Huxley College offers a B.Sc. program specializing in marine bioresources and/or water quality control. The programs emphasize problem solving as a method of teaching and will utilize the facilities of the Northwest Environmental Science Center and the Shannon Point Marine Laboratory.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF BIOLOGY

| | | |
|---|---|---|
| 240 | Marine Biology | 3 |
| 301 | Ecology | 5 |
| 400* | Special Projects in Biology | 2-5 |
| 402 | Limnology | 5 |
| 403* | Physiological Ecology | 5 |
| 406 | General Oceanography | 3 |
| 456 | Algae | 5 |
| 461 | Marine Invertebrate Zoology | 5 |
| 500* | Special Projects in Biology | 2-5 |
| 501* | Thesis Research | 4-9 |
| 503* | Advanced Topics in Ecology (e.g. Biological Oceanography) | 4 |
| 504 | Ecological Instrumentation | 3 |
| 577* | Advanced Topics in Physiology | 4 |
| 583* | Advanced Topics in Biosystematics | 4 |

DEPARTMENT OF GEOLOGY

| | | |
|---|---|---|
| 300* | Special Projects in Geology | 2-5 |
| 310 | Geomorphology | 5 |
| 316 | Paleontology | 5 |
| 340 | Geological Oceanography | 3 |
| 396* | Honors Tutorial | 2-5 |
| 400* | Special Projects in Geology | 2-5 |
| 426 | Micropaleontology | 4 |
| 436 | Paleonecology | 4 |
| 446 | Clay Mineralogy | 4 |
| 496* | Honors Tutorial | 2-5 |
| 500* | Special Projects in Earth Science | 2-5 |
| 507 | Coastal Geology | 4 |
| 516 | Problems in Biostratigraphy | 3 |
| 524 | Sedimentary Petrology and Geochemistry | |
| 546 | Geology of Clays | 3 |
| 570* | Thesis | 3-12 |

*These courses may be offered with a marine emphasis.

WATER QUALITY CONTROL

| | | |
|---|---|---|
| 300 | Huxley Problem Series (emphasis in marine science) | 6 |
| 321 | Investigative Study in Marine Bioresources I | 3 |
| 322 | Investigative Study in Marine Bioresources II | 3 |
| 323 | Investigative Study in Marine Bioresources III | 3 |
| 365 | Introduction to Water Pollution | 4 |
| 366 | Fundamental of Waste Treatment | 4 |
| 367 | Industrial Waste Treatment | 4 |
| 400 | Huxley Problem Series (emphasis | |

| | | |
|---|---|---|
| | in marine science) | 6 |
| 421 | Investigative Study in Marine Bioresources IV | 3 |
| 422 | Investigative Study in Marine Bioresources V | 3 |
| 423 | Investigative Study in Marine Bioresources VI | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGY

Broad, A. Carter, Ph.D., Chairman and Professor of Biology
Dube, Maurice A., Ph.D., Associate Professor of Biology
Heath, Wallace G., PhD., Associate Professor of Biology
Lighthart, Bruce, Ph.D., Assistant Professor of Biology and Director of the Institute for Freshwater Studies
Ross, June P., Ph.D., Professor of Biology
Schneider, David E., Ph.D., Assistant Professor of Biology

DEPARTMENT OF GEOLOGY

Easterbrook, Don J., Ph.D., Professor of Geology and Chairman
Pevear, David R., PhD., Assistant Professor of Geology
Rahm, David A., Ph.D., Associate Professor of Geology
Ross, Charles A., Ph.D., Professor of Geology
Schwartz, Maurice L., Ph.D., Assistant Professor of Geology
Swineford, Ada, Ph.D., Professor of Geology

WATER QUALITY CONTROL

Berg, R. H., Ph.D., Associate Professor of Water Management
Webber, H. H., Ph.D., Assistant Professor of Marine Biology

To obtain further information, address all inquiries directly to:

A. C. Broad, Chairman
Department of Biology
Western Washington State College
Bellingham, Washington 98225

Don J. Easterbrook, Chairman
Department of Geology
Western Washington State College
Bellingham, Washington 98225

Gene W. Miller, Dean
Huxley College
Western Washington State College
Bellingham, Washington 98225

## UNIVERSITY OF WISCONSIN
### MADISON, WISCONSIN

In the past year, the marine sciences facilities at the University of Wisconsin have been substantially expanded. The newly completed Meteorology and Space Sciences building has one floor, about 5500 square feet, devoted to physical oceanography. The administrative offices of the all-Campus Marine Studies Center are also located in this building. The Marine Research Laboratory which is the natural science arm of the Marine Studies Center, is located in a separate building with 7000 square feet of space. A new Engineering Research Building, completed in September, 1969, has most of one floor devoted to ocean engineering.

In addition to these new laboratory facilities, the following facilities continue to be used for marine-related research and graduate training: Civil Engineering Lake Laboratory - fluid modelling; Engineering Hydraulics Laboratory - fluid mechanics and modelling; Geophysics Research Center - marine geophysics; Instrumentation Systems Center - instrumentation; Laboratory of Limnology - hydrobiology; Trout Lake Station - hydrobiology; and Water Chemistry Laboratory-chemical oceanography.

The Oceanic Institute in Hawaii, through a working agreement with the University of Wisconsin, provides field and laboratory facilities for Wisconsin faculty and students. The Center for Great Lakes Studies at the University of Wisconsin-Milwaukee, with its diversified research facilities is available to both staff and students. Extensive use is made of United States Coast Guard vessels on the Great Lakes. The Marine Studies Center has recently acquired a 41-foot research vessel, the AQUARIUS, which is considered an all-University facility, available to any qualified user within the University.

A special ocean minerals' exploration and exploitation program is available to Ph.D. students concentrating in geological oceanography. Student research is frequently conducted in conjunction with the Sea Grant Program and participating undersea mining firms.

Each laboratory facility is fully equipped; the specialized equipment ranges from wave tanks and aquaria to numerous small boats up to 30 feet in length and fixed and barge-borne micrometeorological towers.

Supporting the above facilities is the University Computing Center. Available for use to all marine scientists are an IBM 1460, a CDC 3600, a CDC 1604, Univac 1108, plus appropriate software. The main library contains more than one million volumes; there are specialized libraries for Earth Sciences (including Oceanography), Agriculture and Life Sciences, Biology, and Engineering.

The Ph.D. in Oceanography and Limnology is offered. A minor in oceanography and limnology for Ph.D.'s in other fields is also offered.

The graduate training program in oceanography is administered by the Interdepartmental Committee on Oceanography and Limnology. The program is based on the premise that oceanography and limnology should be considered together as an intergrated field requiring a broad base in fundamental disciplines plus specialization in the application of one particular discipline to the hydrosphere. A student in the program is required to have had mathematics through calculus and one year each in chemistry and physics. In addition, the student, is required to take advanced work in marine and aquatic related subjects in two or more departments and to specialize in a particular aspect of oceanography and limnology, i.e., physical, chemical, geological, or biological. Study plans will be individually tailored for each student by a committee of three professors. At least one semester of marine experience is required.

This is to be broadly interpreted to include research participation at a marine station, sea duty, duty on a floating ice island, systematic aerial measurements of marine phenomena or equivalent.

The following courses are offered in conjunction with the above program:

DEPARTMENT OF BACTERIOLOGY

| | | |
|---|---|---|
| 303 | General Microbiology | 4 |
| 320 | Advanced General Microbiology | 3 |
| 326 | Physiology of Microorganisms | 3-4 |
| 725 | Microbial Ecology | 5 |
| 726 | Advanced Microbial Physiology | 3 |
| 727 | Laboratory Techniques and Microbial Physiology | 1 |
| 730 | Taxonomy and Nomenclature of Bacteria | 4 |
| 731 | Seminar | 1 |

DEPARTMENT OF BOTANY

| | | |
|---|---|---|
| 330 | Algae | 3 |
| 460 | General Ecology | 3 |
| 490 | Physiology and Ecology of Aquatic Plants for Non-Biologists | 2 |
| 801 | Advanced Plant Ecology | 3 |
| 802 | Advanced Plant Ecology | 3 |
| 825 | Ecological Methods | 3 |
| 950 | Seminar in Plant Ecology | 1 |

DEPARTMENT OF ENTOMOLOGY

| | | |
|---|---|---|
| 532 | Aquatic Insects | 3 |

DEPARTMENT OF GEOLOGY AND GEOPHYSICS

| | | |
|---|---|---|
| 130 | Survey of Oceanography | 3 |
| 135 | Environmental Geology | 3 |
| 327 | X-Ray Crystallography | 3 |
| 525 | Micropaleontology | 3 |
| 526 | Micropaleontology | 3 |
| 533 | Geochemistry of Sediments | 3 |
| 535 | Physical Aspects of Sedimentation | 2-3 |
| 537 | Geological Oceanography | 3 |
| 538 | Recent Marine Sediments | 3 |
| 652 | Wave Propagation | 3 |
| 663 | Geophysical Field and Interpretation Methods | 3 |
| 671 | Marine Geophysics | 3 |
| 774 | Problems in Oceanography | 3 |
| 777 | Sea Floor Geological Processes | 3 |
| 977 | Seminar in Sedimentation and Geological Oceanography | 2 |

DEPARTMENT OF METEOROLOGY

| | | |
|---|---|---|
| 130 | Survey of Oceanography | 3 |
| 403 | Micrometeorology | 3 |
| 460 | Physical Oceanography | 3 |
| 461 | Physical Oceanography II | 3 |
| 501 | General Meteorology I | 5 |
| 502 | General Meteorology II | 5 |
| 551 | Geophysical Fluid Dynamics | 3 |
| 662 | Dynamic Oceanography | 2 |
| 663 | Oceanic Density Motions | 2 |
| 774 | Problems in Oceanography | 3 |
| 861 | Problems of Viscous Flow | 2-3 |
| 862 | Problems of Turbulent Flow | 2-3 |
| 960 | Seminar: Oceanography | 1-2 |

DEPARTMENT OF POLITICAL SCIENCE

| | | |
|---|---|---|
| 504 | Science and Government | 3 |

DEPARTMENT OF URBAN/REGIONAL PLANNING

| | | |
|---|---|---|
| 449 | Government and Natural Resources | 3 |
| 821 | Resources Policy Issues: Regional and National | 2-3 |
| 822 | Resources Policy Issues: Regional and National | 2-3 |
| 865 | Water Resources Institutions and Policies | 3 |
| 960 | Seminar in Planning: Impact of Urbanization on Natural Resources Management | 2-4 |
| 965 | Seminar in River Basin Planning | 2-3 |
| 966 | Seminar in Water Resources Planning | 2-3 |

DEPARTMENT OF WATER CHEMISTRY

| | | |
|---|---|---|
| 644 | Water Chemistry | 3 |
| 645 | Water Analysis-Intermediate | 3 |
| 646 | Marine Chemistry | 2 |
| 647 | Water Supply and Pollution Control | 2 |
| 665 | Ocean Environment | 1-3 |
| 679 | Special Topics in Water Chemistry | Var. |
| 770 | Advanced Water Chemistry | 3 |
| 771 | Advanced Techniques of Water Analysis | 3 |
| 772 | Advanced Techniques of Water Analysis II | 3 |
| 773 | Organic Water Chemistry | 2 |
| 774 | Problems in Oceanography | 3 |
| 962 | Water Chemistry Seminar | 1 |

DEPARTMENT OF ZOOLOGY

| | | |
|---|---|---|
| 300 | General Invertebrate Zoology | 3 |
| 500 | Ecology | 3 |
| 510 | Ecology of Fishes | 3 |
| 515 | Limnology--Conservation of Aquatic Resources | 2 |
| 518 | Hydrobiology | 3 |
| 615 | Biology of Aquatic Populations | 3 |
| 955 | Seminar: Limnology | 1 |

SCHOOL OF LAW

| | | |
|---|---|---|
| 812 | Admiralty Law | |
| 827 | International Law | |
| 845 | Water Rights Law | 2 |
| 918 | International Law (Seminar) | 2 |
| 919 | International Organizations | 2 |
| 966 | Water Resource Management | |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BACTERIOLOGY

Brill, Winston, Ph.D., Associate Professor of Bacteriology
Ensign, J. C., Ph.D., Associate Professor of Bacteriology
Hanson, Richard, Ph.D., Associate Professor of Bacteriology
McCoy, Elizabeth, Ph.D., Professor of Bacteriology
Pate, Jack, Ph.D., Assistant Professor of Bacteriology
Wilson, J. B., Ph.D., Professor of Bacteriology

DEPARTMENT OF BOTANY

Adams, Michael, Ph.D., Assistant Professor of Botany
Allen, Timothy, Ph.D., Assistant Professor of Botany
Cottam, Grant, Ph.D., Professor of

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Botany
Gerloff, Gerald C., Ph.D., Professor of Botany
Loucks, Orie L., Ph.D., Professor of Botany
McCracken, Michael, Ph.D., Assistant Professor of Botany

DEPARTMENT OF ENTOMOLOGY

Hilsenhoff, William L., Ph.D., Associate Professor of Entomology

DEPARTMENT OF GEOLOGY AND GEOPHYSICS

Clay, Clarence S., Ph.D., Professor of Geology and Geophysics
Clark, David L., Ph.D., Professor of Geology and Geophysics
Meyer, Robert P., Ph.D., Professor of Geology and Geophysics
Moore, J. Robert, Ph.D., Professor of Geology and Geophysics
Steinhart, John, Ph.D., Professor of Geology and Geophysics

DEPARTMENT OF METEOROLOGY

Bryson, Reid A., Ph.D., Professor of Meteorology
Green, Theodore, Ph.D., Associate Professor of Civil Engineering and Meteorology
Hastenrath, Stefan L., Ph.D., Associate Professor of Meteorology
Lettau, Heinz H., Ph.D. habil., Professor of Civil Engineering and Meteorology
Ragotzkie, Robert A., Ph.D., Professor of Meteorology
Stearns, Charles R., Ph.D., Associate Professor of Meteorology
Young, John A., Ph.D., Associate Professor of Meteorology

DEPARTMENT OF MINERALS AND METALS

Heins, Robert W., Ph.D., Associate Professor of Mining Engineering

DEPARTMENT OF POLITICAL SCIENCES

McCamy, James L., Ph.D., Professor of Political Science

DEPARTMENT OF URBAN/REGIONAL PLANNING

Clarenbach, Fred A., Ph.D., Professor of Urban/Regional Planning
Fox, Irving K., M.A., Professor of Urban/Regional Planning

DEPARTMENT OF WATER CHEMISTRY

Armstrong, David E., Ph.D., Assistant Professor of Water Chemistry
Lee, G. Fred, Ph.D., Professor of Water Chemistry
Veith, Gilbert, Ph.D., Assistant Professor of Civil Engineering

DEPARTMENT OF ZOOLOGY

Dodson, Stanley, Ph.D., Assistant Professor of Zoology
Fraser, Lemuel A., Ph.D., Professor of Zoology
Hasler, Arthur D., Ph.D., Professor of Zoology
Magnuson, John J., Ph.D., Associate Professor of Zoology
Passano, Leonard M., Ph.D., Professor of Zoology
Porter, Warren, Ph.D., Assistant Professor of Zoology

SCHOOL OF LAW

Baldwin, Gordon B., LL.B., Professor of Law
Bilder, Richard, LL.B., Professor of Law
MacDonald, James B., J.D., Professor of Law
Runge, Carlisle P., J.D., Professor of Law

To obtain further information, address all inquiries directly to:

Professor Robert A. Ragotzkie
Chairman, Oceanography and Limnology Committee
University of Wisconsin
1225 West Dayton Street
Madison, Wisconsin 53706

## WOODS HOLE OCEANOGRAPHIC INSTITUTION
### WOODS HOLE, MASSACHUSETTS

The Woods Hole Oceanographic Institution is the only major independent marine research and education institution in the country. Since 1930 when the Institution was established primarily to carry out oceanographic research, education of ocean scientists has been an important, but informal part of the Institution's program. The formal establishment of the Woods Hole Oceanographic Institution as a degree-granting institution took place in 1967.

The Institution is located in Woods Hole, a small village at the southwest corner of Cape Cod, 80 miles south of Boston. The location of the Institution was based on the combined advantages of close proximity to the Marine Biological Laboratory and the Laboratory of the U.S. Bureau of Commercial Fisheries, and of the exceptional opportunities for illustrative investigations in the major divisions of oceanography that is afforded by the neighboring waters. The facilities available to scientists and students alike comprise one of the largest oceanographic research complexes in the country. Currently in Woods Hole the Institution operates four principal research laboratories, a number of smaller buildings for support services, and waterfront facilities for tending a fleet of four sea-going research vessels, a deep submergence research vehicle and support vessel, and a number of smaller boats. The laboratories, well-equipped for research in biological, chemical, and physical oceanography, and marine geology and marine geophysics, and in ocean engineering, are backed up by available computer services through the Institution's own Information Processing Center, and the combined library resources of the Institution, Marine Biological Laboratory and the Bureau of Commercial Fisheries station.

Graduate degree programs at the Woods Hole Oceanographic Institution are carried out as a cooperative effort with several other noted universities. Students may register in the Joint Program in Oceanography conducted with the Massachusetts Institute of Technology for programs of

study and research leading to a joint doctoral degree - a single document issued jointly by both institutions. The Joint Program in Oceanography is administered by both institutions and constitutes the major pathway for the majority of students entering the graduate degree program at Woods Hole. Programs of study and research leading to a doctoral degree in oceanography awarded by the Woods Hole Oceanographic Institution alone, are offered for the student whose area of interest is not best served by the Joint Program. Through a cooperative agreement with Harvard University, students registered for a graduate degree at Woods Hole may enroll for course work and related study at Harvard in accordance with the usual cross-registration procedures. In areas relating to paleontology and marine biology, a similar agreement is in force between Woods Hole and Yale University.

The following degrees are offered:

1. Ph.D. and Sc.D. in Oceanography, offered jointly by W.H.O.I. and M.I.T.
2. Ph.D. in Oceanography offered by the Woods Hole Oceanographic Institution.

Students in either doctoral degree program may concentrate in one or more of the following areas: biological oceanography, chemical oceanography, marine geology, marine geophysics, or physical oceanography. The usual steps to a degree are:

(1) Enter the program in the summer preceding the first academic year and work as a research assistant in Woods Hole.

(2) Follow an individually designed program of advanced study and research in preparation for a general examination to be taken before the third year. The general examination tests for a comprehensive knowledge of oceanography and ability to identify and explore research problems.

(3) Meet the recommended language requirements (not required in the Joint Program) of a reading ability of the scientific literature in two acceptable foreign languages.

(4) Submit a dissertation on significant original theoretical or experimental research and conduct an oral defense of the thesis.

Students must be capable of self-directed work. Preparation for the general examination is carried out on an individual basis. Each student formulates, with the assistance of his academic advisors (one from each institution), a program of studies usually involving subjects, seminars and research activities. There are no formal course requirements, but each degree candidate is expected to gain some degree of familiarity with the principle areas of oceanography, in addition to demonstrating a thorough knowledge of at least one major field of specialization.

A student's place of residence is determined by his outlined program of study and research. A student in the Joint Program is encouraged to spend some time in residence at both M.I.T. and Woods Hole, in order to take full advantage of the breadth of interests of the staffs, as well as the combined facilities of the two institutions.

The Woods Hole degree programs are founded on the principle that oceanography is an interdisciplinary science, and therefore an interdisciplinary approach is virtually mandatory. To this end the following series of basic studies is offered:

BIOLOGICAL OCEANOGRAPHY

The special adaptations of organisms for life in the sea and the impact of biological processes on the non-living components of the marine environment provide the core of biological oceanography studies. Among the ideas emphasized are the cycling of energy and matter through the marine ecosystem, and the factors regulating the abundance, distribution, and community organization of marine micro-organisms and metazoans. Through laboratory and shipboard work the student is introduced to the marine environment and to the methods of studying the organisms and biological processes that occur in the sea.

CHEMICAL OCEANOGRAPHY

Topics to be covered include major ion composition, ionic species and equilibrium concepts, trace elements, the carbonate and silicate systems, dissolved gases, stable isotopes, radionuclides, and organic matter in the sea. The cycle of nutrients in the ocean, their relation to productivity and the chemical changes associated with bacterial oxidation will be discussed. The course will integrate the marine geochemistry of the lithosphere, atmosphere and biosphere. Lectures on selected topics will be given by various members of the Woods Hole Staff.

MARINE GEOLOGY

The physiography, stratigraphy, and structure of the ocean floor and processes of its evolution and modification; major results of early oceanographic expeditions and summary of first concepts; development of instruments and methods, including a brief review of sampling devices and underway techniques, such as echosounding and seismic reflection; theories of ocean basin evolution; composition, origin and transportational history of marine sediments; application of present knowledge of the modern marine environment to the genetic interpretation of ancient rocks.

MARINE GEOPHYSICS

Crustal and upper mantle structure of continental margins, ocean basins, island arcs and oceanic ridges; and implications for deep earth structure and dynamic processes. Introductory theory and application of techniques in seismic reflection, seismic refraction, and earthquake seismology; earth gravity; geomagnetism; and heat flow. Current instrumentation and data processing techniques.

PHYSICAL OCEANOGRAPHY

Two basic courses in physical oceanography are offered: one for students specializing in physical oceanography, geophysics or engineering; the other for students specializing in other branches of oceanography. The prerequisites and methods of instruction differ considerably, especially in mathematical content.

The first course treats analytically the classical theories of oceanic dynamics and incorporates, whenever appropriate, new

ideas from the contemporary literature. A short introduction, including a review of the fluid mechanics and mathematics pertinent to the course, is followed by treatments of general oceanic circulation, oceanic boundary layers, waves and tides, and thermohaline circulation. Familiarity with boundary value problems, vector analysis, and the mechanics of deformable media would be desirable.

The other course, especially intended for biologists, chemists and geologists, is an introductory account of the elements of physical oceanography. The following topics are discussed: coordinate systems and the geometry of the earth's crust, the astronomical tides, the conservation laws, types and scales of oceanic variability, the physical properties of sea water, the carbon dioxide system, the transmission of acoustic and electromagnetic energy, the planetary energy budget and the air-sea interaction, the general oceanic circulation and distribution of properties, sediment transport. The prerequisites are an introductory course in physics and mathematics through integral calculus.

Other subjects, seminars, and research topics offered in response to student interest are:

Natural History of Midwater Fishes
Temperature Regulation in Fishes
Salt Marsh Ecology
Animal Diversity
Deep Sea Biology
Experimental Biology of Larvae from the Benthos
Biochemical Circulation of Organic Compounds
Plant Pigments
Diving Physiology
Selected Systematic Problems in the Ocean
Marine Microbiology
Organic Geochemistry
Marine Chemotaxis
Trace Elements in the Oceans
Elementary Statistics in Earth Sciences
Multivariate Statistics in Earth Sciences
Isotope Geochemistry
Major Elements in Sea Water
Geochemical Studies of the Sea Floor
Geochemical Studies by Neutron Activation
Structure of Water and Aqueous Solutions
Potential Theory in Marine Geophysics
Magnetism of Rocks and Sediments
Micro-Paleontology and Its Application to Oceanographic Research
Marine Seismology
Underwater Acoustics
Marine Sediments
Geomorphology and Structure of Ocean Basins and Continental Margins
Island Arcs and Mid-Ocean Ridges
Exploration Geophysics in the Ocean Environment
Marine Geodesy
Physics of the Hydrosphere
Sea-Surface Oceanography
Physical Properties of Sea Water
Gulf Stream
Electromagnetic Fields in the Sea
Remote Sea-Surface Temperature Measurements
Dynamics of the Florida Current
Long Wave Theory
Oceanic Variability
General Circulation of the North Atlantic
Waves and Turbulence

For the courses offered at M.I.T., the reader should refer to the index.

The Woods Hole Oceanographic Institution also offers, jointly with M.I.T., graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the subjects, seminars, and thesis topics listed above consist of the following members of the Resident Scientific and Technical Staff:

Atema, Jelle, Ph.D., Chemist and Assistant Scientist
Backus, Richard H., Ph.D., Biologist and Senior Scientist
Beckerle, John C., Ph.D., Physicist and Associate Scientist
Berggren, William A., D.Sc., Micropaleontologist and Associate Scientist
Blumer, Max, Ph.D., Organic Geochemist and Senior Scientist
Bowen, Vaughan T., Ph.D., Geochemist and Senior Scientist
Bowin, Carl O., Ph.D., Geologist and Associate Scientist
Boylan, David B., Ph.D., Chemist and Assistant Scientist
Bradshaw, Alvin L., M.A., Applied Physicist and Research Specialist
Brewer, Peter G., Ph.D., Chemist and Assistant Scientist
Bryan, Wilfred B., Ph.D., Petrologist and Associate Scientist
Bumpus, Dean F., B.A., Oceanographer and Senior Scientist
Bunce, Elizabeth T., M.A., Geophysicist and Associate Scientist
Bunker, Andrew F., M.A., Meteorologist and Associate Scientist
Carey, Frank G., Ph.D., Biologist and Associate Scientist
Chase, Joseph, Ph.D., Meteorologist and Associate Scientist
Craddock, James E., Ph.D., Biologist and Assistant Scientist
Daubin, Scott C., Ph.D., Engineer/Physicist and Senior Scientist
Davis, James A., Ph.D., Geologist and Assistant Scientist
Degens, Egon T., Ph.D., Geochemist and Senior Scientist
Deuser, Werner G., Ph.D., Geochemist and Associate Scientist
Emery, Kenneth O., Ph.D., Marine Geologist and Senior Scientist
Ewing, Gifford C., Ph.D., Oceanographer and Senior Scientist
Fofonoff, Nicholas P., Ph.D., Oceanographer and Senior Scientist
Fuglister, Frederick C., Oceanographer and Senior Scientist
Grassle, J. Frederick, Ph.D., Biologist and Assistant Scientist
Grice, George D., Ph.D., Zoologist and Associate Scientist
Guillard, Robert L., Ph.D., Biologist and Associate Scientist
Haedrich, Richard L., Ph.D., Biologist and Associate Scientist
Harvey, George R., Ph.D., Chemist and Assistant Scientist
Hathaway, John C., M.S., Geologist, U.S. Geological Survey
Hays, Earl E., Ph.D., Physicist and Senior Scientist
Heirtzler, James R., Ph.D., Physicist and Senior Scientist
Hollister, Charles D., Ph.D., Geologist

and Assistant Scientist
Horne, Ralph A., Ph.D., Chemist and Associate Scientist
Hoskins, Hartley, Ph.D., Geophysicist and Assistant Scientist
Hulburt, Edward M., Ph.D., Biologist and Associate Scientist
Hunt, John M., Ph.D., Geochemist and Senior Scientist
Jannasch, Holger W., Ph.D., Microbiologist and Senior Scientist
Kanwisher, John W., Ph.D., Biophysicist and Senior Scientist
Katz, Eli J., Ph.D., Fluid Mechanist and Associate Scientist
Ketchum, Bostwick H., Sc.D., Biologist and Associate Director
Knott, Sydney T., Hydroacoustics Engineer and Research Specialist
Lorenzen, Carl J., Ph.D., Biologist and Assistant Scientist
Luyendyk, Bruce P., Ph.D., Geologist and Assistant Scientist
Manheim, Frank T., Ph.D., Geochemist, U.S. Geological Survey
Mather, Frank J., III, B.S., Biologist and Associate Scientist
Maxwell, Arthur E., Ph.D., Oceanographer and Director of Research
McElroy, Paul T., Ph.D., Physicist and Assistant Scientist
Meade, Robert H., Ph.D., Geologist-Hydrologist, U.S. Geological Survey
Metcalf, William G., M.S., Physical Oceanographer and Associate Scientist
Miller, Arthur R., Physical Oceanographer and Associate Scientist
Milliman, John D., Ph.D., Oceanographer and Assistant Scientist
Murphy, Edward L., Ph.D., Physicist and Associate Scientist
Noshkin, Victor E., Ph.D., Nuclear Chemist and Associate Scientist
Phillips, Joseph D., Ph.D., Geophysicist and Associate Scientist
Remsen, Charles C., Ph.D., Microbiologist and Assistant Scientist
Rosenfeld, Melvin A., Ph.D., Geologist and Senior Scientist
Ross, David A., Ph.D., Geological Oceanographer and Associate Scientist
Rowe, Gilbert, Ph.D., Biologist and Assistant Scientist
Ryther, John H., Ph.D., Biologist and Senior Scientist
Sanders, Howard L., Ph.D., Biologist and Senior Scientist
Sanford, Thomas B., Ph.D., Physical Oceanographer and Assistant Scientist
Saunders, Peter M., Ph.D., Meteorologist and Associate Scientist
Sayles, Frederick L., Ph.D., Chemist and Assistant Scientist
Scheltema, Rudolf S., Ph.D., Biologist and Associate Scientist
Schevill, William E., M.A., Associate in Oceanography
Schlee, John S., Ph.D., Geologist, U.S. Geological Survey
Schleicher, Karl E., B.A., Oceanographic Engineer and Research Specialist
Schmitz, William J., Jr., Ph.D., Physical Oceanographer and Assistant Scientist
Sears, Mary, Ph.D., Biologist and Senior Scientist
Simmons, William F., Ph.D., Physical Oceanographer and Assistant Scientist
Spencer, Derek W., Ph.D., Geochemist and Associate Scientist
Teal, John M., Ph.D., Biologist and Associate Scientist
Thompson, Geoffrey, Ph.D., Geochemist and Associate Scientist
Todd, John, Ph.D., Chemist and Assistant Scientist
Uchupi, Elazar, Ph.D., Geologist and Associate Scientist
Vaccaro, Ralph F., M.P.H., Biologist and Associate Scientist
Vine, Allyn C., M.S., Oceanographer and Senior Scientist
von Arx, William S., Sc.D., Oceanographer and Senior Scientist
von Herzen, Richard P., Ph.D., Geophysicist and Associate Scientist
Voorhis, Arthur D., Ph.D., Physical Oceanographer and Associate Scientist
Wall, David, Ph.D., Geologist and Associate Scientist
Warren, Bruce A., Ph.D., Physical Oceanographer and Associate Scientist
Watson, Stanley W., Ph.D., Biologist and Senior Scientist
Webster, T. Ferris, Ph.D., Physical Oceanographer and Senior Scientist
Whitney, Geoffrey G., Jr., Oceanographer and Research Associate
Wiebe, Peter, Ph.D., Biologist and Assistant Scientist
Wilson, Roger S., Ph.D., Analytical Chemist and Assistant Scientist
Wong, How-Kin, Ph.D., Physicist and Assistant Scientist
Worthington, L. Valentine, Physical Oceanographer and Senior Scientist
Wright, W. Redwood, Ph.D., Physical Oceanographer and Assistant Scientist
Zafiriou, Oliver C., Ph.D., Geochemist and Assistant Scientist
Zarudski, Edward, M.S., Seismic Engineer and Research Specialist

To obtain further information, address all inquiries directly to:

Dr. H. Burr Steinbach
Dean of Graduate Studies
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

# *CONSORTIA IN*

# *MARINE SCIENCE*

## GULF COAST RESEARCH LABORATORY
### OCEAN SPRINGS, MISSISSIPPI

The Gulf Coast Research Laboratory offers summer courses in marine biology and marine geology as well as year-round instruction and research programs leading to the M.S. and Ph.D. degrees in such areas as Biological Electron Microscopy, Morphology, Microbiology, Taxonomy, Biochemistry, Fisheries Biology, Marine Ecology, Bioenergetics and Aquatic Systems.

The Laboratory is a non-profit educational institution and is affiliated with the following colleges and universities:

Alcorn State College
Belhaven College
Delta State College
Jackson State College
Millsaps College
Mississippi College
Mississippi State College for Women
Mississippi State University
Mississippi Valley State College
University of Mississippi
University of Southern Mississippi
William Carey College
Auburn University
Bowling Green University
Jamestown College
Lambuth College
Louisiana State University
McNeese State College
Memphis State University
Northeast Louisiana State College
Northwestern State University of Louisiana
Northwest Missouri State College
Southern Methodist University
Southwest Missouri State College
Southwestern Oklahoma State College
Tennessee Technological University
Tennessee Wesleyan College
Troy State College
Westmar College

The Laboratory facilities consist of four brick buildings, two of which are teaching laboratories and two of which are research laboratories. There are also dormitories for 120 people, a modern shop, a dining hall, and some ten boats ranging in size from 18 to 65 feet in length.

The following courses are offered during the summer:

UNDERGRADUATE

| | | |
|---|---|---|
| Zool 141 | Introduction to Marine Zoology | 4 |

UNDERGRADUATE OR GRADUATE

| | | |
|---|---|---|
| Geol 361 | Physical Marine Geology | 3 |
| Geol 362 | Chemical Marine Geology | 3 |
| Bot 361 | Marine Botany | 4 |
| Zool 361A | Marine Invertebrate Zoology | 6 |
| Zool 362 | Marine Vertebrate Zoology and Ichthyology | 6 |
| Zool 460 | Special Problems in Advanced Histology | 3-6 |

GRADUATE

| | | |
|---|---|---|
| Zool 561 | Problems in Zoology | 3-6 |
| | National Science Foundation Summer Research Program | 4 |

Graduate research for the M.S. and Ph.D. degrees is offered year-round in numerous phases of marine science, i.e., biological electron microscopy, morphology, microbiology, taxonomy, biochemistry, fisheries biology, and marine ecology. Applicants should write to the Registrar for information on the National Science Foundation Summer Research Program and the Graduate Research program.

The instructional staff for the courses listed above consists of the following:

Ballard, Buena S., Ph.D., Department of Biology, Southwestern State College of Oklahoma
Channell, R.B., Ph.D., Professor of Biology, Vanderbilt University
Friauf, James J., Ph.D., Professor of Biology, Vanderbilt University
Gunter, Gordon, Ph.D., Director, Gulf Coast Research Laboratory
Howse, Harold D., Ph.D. Electron Microscopist, Guld Coast Research Laboratory
Rivas, Luis R., BL-BS (French System), Fisheries Biologist, Bureau of Commercial Fisheries, Pascagoula, Mississippi, Professor of Zoology, Gulf Coast Research Laboratory
Siler, Walter L., B.S., Geologist, Gulf Coast Research Laboratory
Snowden, Jesse O., Jr., Ph.D., Associate Professor of Geology, Louisiana State University in New Orleans

For further information on any of the participating universities or colleges, please write the university or college directly.

For further information on graduate research, please contact:

Registrar
Gulf Coast Research Laboratory
Ocean Springs, Mississippi 39564

## GULF UNIVERSITIES RESEARCH CORPORATION
### COLLEGE STATION, TEXAS

The Gulf Universities Research Corporation is a non-profit consortium of 21 universities and research institutes located near, and sharing interests in, the Gulf of Mexico and persons living on the periphery of the Gulf.

The aims of the corporation are research, education, and public service, in pursuit of which the corporation will establish centralized research facilities in scientific areas of interest to its membership and in areas where the needs for supporting services and equipment are on such a large scale as to make single university ownership impractical or undesirable. Present interest of the corporation is in basic and applied research in marine science, including marine meteorology, physical oceanography, marine biology, marine geology, marine geophysics, pollution, remote sensing, and chemical oceanography.

The participating universities and research institutes are:

Florida State University
Gulf South Research Institute
Lamar State College of Technology
Louisiana State University
Mississippi State University
Rice University
Southern Methodist University
Southwest Research Institute
Texas A&M University

Texas Christian University
Texas Technological University
Tulane University
University of Alabama
University of Florida
University of Houston
University of Mexico
University of Miami
University of Mississippi
University of Southern Mississippi
University of Texas
University of West Florida

Corporation Headquarters are at 227 System Building, College Station, Texas, 77843. For further information on any of the participating universities or research institutes, please contact the university or institute directly.

## THE MARINE BIOMEDICAL INSTITUTE
### GALVESTON, TEXAS

The Marine Biomedical Institute is jointly sponsored by The University of Texas Medical Branch and Texas A&M University, Galveston, Texas. Approximatel 7300 square feet of new laboratory space in the Sealy-Smith Professional Building adjacent to the campus of The University of Texas Medical Branch at Galveston is available.

The Institute offers doctoral and post-doctoral training in the Marine Biomedical Sciences to selected students. Degrees are conferred by the sponsoring institutions upon satisfactorily meeting their requirements.

No formal courses are offered. Graduate training is given according to the individual requirements of the student and comensurate with the academic requirements of the sponsoring institution.

The instructional staff consists of:

Wolf, Stewart, M.D., Director of MBI; Professor of Medicine and Physiology, UTMB; System Professor, The University of Texas System

MARINE MEDICINE DIVISION

Beckman, Edward L., M.D., Chief of Marine Medicine Division, MBI; Professor of Physiology, UTMB

COMPARATIVE NEUROBIOLOGY DIVISION

Blankenship, James E., Ph.D., Assistant Professor of Physiology, UTMB

Willis, William D., Jr., M.D., Ph.D., Chief of Comparative Neurobiology Division MBI; Professor of Physiology and Anatomy, UTMB

BIOCHEMISTRY SECTION

Haber, Bernard, Ph.D., Chief, Biochemistry Section, MBI; Assistant Professor of Biochemistry, UTMB

To obtain further information, address all inquiries directly to:

Stewart Wolf, M.D., Director
The Marine Biomedical Institute
200 University Boulevard
Galveston, Texas 77550

## MARINE SCIENCE CONSORTIUM OF PENNSYLVANIA COLLEGES AND UNIVERSITIES

Participating Institutions:

Bloomsburg State College, Bloomsburg, Pa. 16912
Catholic University, Washington, D.C. 20000
Edinboro State College, Edinboro, Pa. 16412
Indiana University of Pennsylvania, Indiana, Pa. 15701
Kutztown State College, Kutztown, Pa. 19530
Millersville State College, Millersville Pa. 17551 (Administrative Center)
Shippensburg State College, Shippensburg, Pa. 17257
Slippery Rock State College, Slippery Rock, Pa. 16057
West Chester State College, West Chester, Pa. 19380

Each of the participating institutions offers one or more courses in oceanography, for which classroom facilities, laboratory space, modest library support and access to computers are available on the various campuses.

In addition, the Consortium operates two "Marine Science Centers", one in Lewes, Delaware, the other in Wallops Island, Virginia, each having living facilities for up to 60 students and faculty. Several classrooms, wet and dry laboratories, boat houses, workshops and garages as well as docking facilities for small vessels are part of the Centers. At Wallops Island, the Consortium has cooperative arrangements with the NASA Space Center.

A 60 x 12-foot fully equipped, air-conditioned mobile laboratory is available. This trailer consists of a diving locker, sedimentation lab, weighing and microscope room, drafting room, office and conference room.

Vessels include:

1. a 34 x 15-foot research catamaran, with center well, traveling overhead gantry, hydrowinch, radar, loran-C, depth-recorder, and VHF radio. Propulsion is by twin inboard-outboard diesels (90 H.P. each), and the action radius is about 900 miles.
2. a 38-foot converted Sportfisher, SANDPEBBLE, with davits and handwinches, depth-sounder and VHF radio, one 250 H.P. gasoline engine, single screw.
3. a 30-foot converted lobster fisher, LYDIA B., with A-frame handwinches, depth-sounder, diving platform and hookah-diving equipment, one 150 H.P. gasoline engine, single screw.
4. four small boats are used for near-shore work.

Two 12 passenger sportvans are available, through grants by Pennsylvania Science and Engineering Foundation, for fieldtrips along the coast.

Undergraduate degrees consist of B.A. and B.S. in Education, Biology, Geology, Geography, Earth and Space Science, etc. At graduate level, the M.Ed. in Science is available at most of the State Colleges, and the M.A. and M.S. in some. Catholic University offers a Master's Degree and a Ph.D. in Ocean Engineering.

In participating institutions with a divisional structure, marine science courses

are restricted to the Division of Science. On the departmental level, oceanography courses are offered in the departments of geography, geology, geoscience and earth and space science (depending on the particular institution), and marine biology courses in the biology department. Ocean engineering is offered at Catholic University in the Department of Civil Engineering.

All of the following courses are offered during the three week summer session at the Centers. Those also offered at participating institutions during the year are so indicated by an asterisk.

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| MS 110 | Introductory Oceanography<br>Bloomsburg State College<br>Catholic University<br>Millersville State College*<br>Indiana University of Pennsylvania<br>Kutztown State College*<br>Slippery Rock State College<br>West Chester State College | 3 |
| MS 211 | Field Methods in Nearshore and Estuarine Oceanography | 3 |
| MS 221 | Invertebrate Zoology<br>Kutztown State College<br>Millersville State College* | 3 |
| MS 241 | Marine Biology<br>Millersville State College | 3 |
| MS 260 | Marine Ecology | 3 |
| MS 261 | Marine Botany | |
| MS 331 | Chemical Oceanography<br>Millersville State College* | 3 |
| MS 362 | Marine Geology<br>Millersville State College* | 3 |
| MS 364 | Physical Oceanography<br>Catholic University | 3 |
| MS 420 | Marine Micropaleontology | 3 |
| MS 457 | Marine Geophysics | 3 |
| MS 500 | Problems in Marine Science | 3-6 |

GRADUATE COURSES

For information about graduate courses, including N.S.F. summer institutes, contact the Marine Science Consortium.

The instructional staff for the courses listed above consists of the following:

BLOOMSBURG STATE COLLEGE

GEOLOGY DEPARTMENT

Lauffer, James, M.S., Associate Professor, Geology

CATHOLIC UNIVERSITY

DEPARTMENT OF CIVIL ENGINEERING

Gilheany, John, Ph.D., Associate Professor, Ocean Engineering

EDINBORO STATE COLLEGE

GEOLOGY DEPARTMENT

Wegweiser, Arthur, Ph.D., Chairman, Department of Geology, Professor, Geology

INDIANA UNIVERSITY OF PENNSYLVANIA

BIOLOGY DEPARTMENT

Liegey, Frank, Ph.D., Chairman, Department of Biology, Vice-President of Marine Science Consortium, Professor, Microbiology, Cell Physiology

GEOSCIENCE DEPARTMENT

Prince, Paul A., M.A., Associate Professor, Oceanography and Meteorology

KUTZTOWN STATE COLLEGE

GEOGRAPHY-GEOLOGY DEPARTMENT

Mobley, Mary, M.S., Assistant Professor, Oceanography

MILLERSVILLE STATE COLLEGE

BIOLOGY DEPARTMENT

Miller, Kenneth G., M.S., Associate Professor, Ecology

CHEMISTRY DEPARTMENT

Davis, Donald R., Ph.D., Assistant Professor, Marine Chemistry, Water Pollution

EARTH & SPACE SCIENCE DEPARTMENT

Oostdam, Bernard L., M.S., President, Marine Science Consortium, Associate Professor, Oceanography, Marine Geology

SHIPPENSBURG STATE COLLEGE

BIOLOGY DEPARTMENT

Rogers, W.E., Ph.D., Associate Professor, Biology

SLIPPERY ROCK STATE COLLEGE

BIOLOGY DEPARTMENT

Strickle, Willaim, Ph.D., Assistant Professor, Biology

GEOLOGY DEPARTMENT

Bushnel, Kent, Ph.D., Associate Professor, Geophysics
Szucs, F.K., Sc.D., Chairman, Department of Geology, Professor, Geochemistry
Ward, Albert, Ph.D., Associate Professor, Geology

WEST CHESTER STATE COLLEGE

BIOLOGY DEPARTMENT

Jones, Harry, M.S., Assistant Professor, Ecology

GEOLOGY DEPARTMENT

Ehleiter, John, M.A., Associate Professor, Oceanography
Greenberg, Seymour S., Ph.D., Professor, Geology

For admission to summer sessions, address all inquiries directly to:

Prof. B.L. Oostdam
Marine Sciene Consortium
P.O. Box 43
Millersville, Pennsylvania 17551

For admission to one of the participating institutions contact the Admission Office of the Dean of Academic Affairs of the appropriate participating institution.

## MOSS LANDING MARINE LABORATORIES
## CALIFORNIA STATE COLLEGES
### MOSS LANDING, CALIFORNIA

Five California State Colleges (at Fresno, Hayward, Sacramento, San Francisco, and San Jose) jointly operate this seaside facility as a year--around center for upper division and graduate level education and research in the marine sciences. An average of 40 units of course work, plus Master's research and thesis, are provided every term (fall, spring, summer). The Laboratories face west on Monterey Bay at the point of origin of a deep submarine canyon. To the east, Moss Landing Harbor opens upon the diversified intertidal marsh and mudflat habitats of Elkhorn Slough. The buildings provide 14,000 square feet of classroom, research, laboratory, office, and library space, equipped to support the diversified curriculum and research needs of a multidisciplinary operation. Skiffs and small boats (8 to 24 feet) provide access to the nearshore marine and estuarine environments upon which the Laboratories focus primary instructional and research emphasis. A privately owned 55-foot oceanographic vessel is affiliated with the Laboratories, and is available for deeper water research on the continental shelf through cooperative arrangements with governmental and private organizations in the vicinity.

Since the Moss Landing Marine Laboratories are an integral part of five separate supporting colleges, degrees are earned through those colleges. Baccalaureate and Master's degrees in the basic sciences (e.g., Biology, Chemistry, Geology, Meteorology) may include concentrations in the marine field, to include one or more semesters of study at the Moss Landing Marine Laboratories. While details differ in the several institutions, the following general notes apply.

1. B.A. or B.S. in Biology, Botany, or Zoology. Marine Sciences requirements at Moss Landing Marine Laboratories include General Oceanography, Marine Ecology, Marine Science Techniques, and Literature of the Marine Sciences, plus electives appropriate to the major interest. In the California State Colleges, a minimum of 124 units are required for the bachelor's degree, of which 45 must be in broad general education areas.

2. B.A. or B.S. in Geology. The marine sciences concentration will be similar to that for biology, with recommended electives including Marine Meteorology, Marine Biogenic Sediments, and Geological Oceanography.

3. M.A. or M.S. in Biology, Geology, Meteorology, or Chemistry. Thirty graduate units, to include six to ten units of required core courses, and research and thesis are required for the Master's degree. Some institutions also require reading competence in a foreign language. The Marine Sciences concentration usually includes a full year of work at the Moss Landing Marine Laboratories, with research and thesis on a marine environmental topic.

The Moss Landing Marine Laboratories curriculum supports two primary disciplines -- marine biology and marine geology -- for all five participating colleges. Occasional course offerings also support majors in meteorology (San Jose State College), geography, and engineering. Special summer workshops and year-around seminar and special topics courses are designed for in-service marine sciences instruction of teachers at all levels.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 101 | General Oceanography | 4 |
| 102 | Marine Science Techniques | 2 |
| 111 | Zoology of Marine Vertebrates | 4 |
| 121 | Marine Invertebrate Zoology | 4 |
| 131 | Marine Algology | 3 |
| 133 | Micropaleontology | 3 |
| 135 | Marine Meteorology | 3 |
| 137 | Marine Biogenic Sediments | 3 |
| 141 | Geological Oceanography | 3 |
| 153 | Marine Science Diving | 2 |
| 154 | SCUBA Marine Research | 3 |
| 161 | Marine Ecology | 4 |
| 170 | Marine Environmental Research Part. | 3-4 |
| 180 | Independent Study | 1-4 |
| 181 | Literature of the Marine Sciences | 1 |
| 196 | Topics in Marine Science | 3 |
| | a) Marine Invertebrate Physiology | |
| | b) Marine Invertebrate Embryology | |
| | c) Coastal Geomorphology | |
| | d) Ichthyology | |
| | e) Marine Birds and Mammals | |
| | f) Physical and Chemical Oceanography | |

GRADUATE COURSES

| | | |
|---|---|---|
| 201 | Concepts of Marine Science | 3 |
| 255 | Advanced Topics in Marine Science | 3 |
| | a) Biology of the Mollusca | |
| | b) Environmental Studies and Techniques | |
| | c) Seminar in Regional Geography | |
| | d) Behavior of Marine Animals | |
| | e) Population Biology | |
| | f) Continental Drift | |
| | g) Environmental Geology | |
| | h) Topics in Invertebrate Zoology | |
| | i) Research in Monterey Bay | |
| | j) Paleoecology | |
| 262 | Advanced Marine Ecology | 3 |
| 277 | Human Geography and Ecology | 3 |
| 285 | Graduate Seminar | 2 |
| 298 | Research in Marine Science | 1-4 |
| 299 | Master's Thesis | 1-4 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF BIOLOGICAL SCIENCES

Albin, Patrick, N.A.U.I. Diving Captain and Instructor, San Francisco State College
Bell, Charles W., Ph.D., Associate Professor of Biology, San Jose State College
Harville, John P., Ph.D., Professor of Biology, San Jose State College
Jensen, James B., M.A., Assistant Professor of Biology, California State College, Hayward
Morejohn, G. Victor, Ph.D., Professor of Biology, San Jose State College
Nybakken, James W., Ph.D., Associate Pro-

fessor of Biology, California State College, Hayward
Parrish, Richard H., M.S., Instructor in Biological Sciences, San Jose State College
Tomlinson, Jack T., Ph.D., Professo f Biology,San Francisco State College
Yarberry, Edgar L., Ph.D., Assistant Professor of Biology, San Jose State College

DEPARTMENT OF GEOLOGY

Arnal, Robert E., Ph.D., Director, Moss Landing Marine Laboratories, and Professor of Geology and Oceanography, San Jose State College
Broenkow, William W., Ph.D., Assistant Professor of Chemistry and Oceanography, San Jose State College
Dillon, William, Ph.D., Assistant Professor of Geology, San Jose State College

DEPARTMENT OF METEOROLOGY

Read, Robert G., M.S., Associate Professor of Meteorology, San Jose State College

DEPARTMENT OF GEOGRAPHY

Gordon, Burton L., Ph.D., Professor of Geography, San Francisco State College

To obtain further information, address all inquiries directly to:

Assistant to the Director
Moss Landing Marine Laboratories
P.O. Box 223
Moss Landing, California 95039

## NEW HAMPSHIRE COLLEGE AND UNIVERSITY COUNCIL

The New Hampshire College and University Council supports an interinstitutional Marine Science Program involving ten colleges:

Keene State College, Keene, N.H.
New England College, Henniker, N.H.
Franklin Pierce College, Rindge, N.H.
Mt. St. Mary College, Hooksett, N.H.
Notre Dame College, Manchester, N.H.
Plymouth State College. Plymouth, N.H.
Rivier College, Nashua, N.H.
St. Anselm's College, Manchester, N.H.
Suffolk University, Boston, Mass.
University of New Hampshire, Durham, N.H.

The program consists of an introductory course in Marine Science for undergraduates. The course is offered in the fall and spring semesters of each academic year. It is a multidisciplinary, team-taught course which deals with the general and introductory aspects of chemical oceanography, physical oceanography, marine geology, and biological oceanography. The course includes lectures, laboratory work, field trips, and seminars. Students may enroll in either term through application through the institutions' Marine Science Committee member.

A summer institute consisting of three courses will be conducted each summer at a location designated by the Marine Science Committee. Students selected for this program may not enroll for more than two of the courses offered. Students will be selected at each institution to a limit of three for this institute. The courses selected for presentation in the institute will be announced each year generally in conjunction with summer school notifications.

The program is open to all undergraduates of the member institutions with selection being made by the parent institution of the student and in accordance with any prerequisites established for any of the offerings. The intent of the program is to be general on the one hand for the interested student who may or may not be interested in preparing for future careers in Marine science; and on the other hand for those students that want in-depth studies in ocean-oriented studies. This is accomplished by a combination of introductory level courses in the regular terms and discipline oriented courses during the summer institute. No prerequisites within the program are made to establish eligibility for participation.

All offerings will utilize the facilities and equipment of the member institutions. This includes a field station on the shores of Cobscook Bay in Maine, vessels associated with the Jackson Estuarine Laboratory and the laboratories of the participating institutions. Resources of other agencies and institutions will be used to supplement the program from time to time.

The faculty is selected from the member institutions on the basis of their expertise in specific disciplines within the marine sciences. All appointments and program proposals are made by the Curriculum Committee of the COSIP project.

To obtain further information, address all inquiries directly to:

Sister Janice Godzyk
Mount Saint Mary College
Hooksett, N.H. 03106

## NEW JERSEY MARINE SCIENCES CONSORTIUM
## RICHARD STOCKTON STATE COLLEGE
### POMONA, NEW JERSEY

The New Jersey Consortium offers marine science courses at the 400, 500, and 600 series level at its laboratory-field station, Cape May Point, New Jersey. Six courses will be available for the summer of 1971. In addition to summer courses, the station is open to educational field trips and graduate and faculty research throughout the regular academic year. The Cape May station has docking and small craft facilities for estuarine and shallow water shelf studies.

No degrees are offered directly by the Consortium. However, accreditation of the courses is made toward degrees in the various disciplines by the member institutions.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| 400 | Introduction to Oceanography | 4 |
| 400 | Marine Biology | 4 |
| 400 | Littoral Geologic Processes | 4 |
| 400 | Marine Botany | 4 |
| 600 | Ecology of the Estuary | 4 |
| 400 | Independent Study | 1-4 |
| 500 | Independent Study | 1-4 |
| | Scuba Training | No Credit |

The fee for Scuba Training is $80.00 (subject to change), and includes the cost of equipment and room and board for the week.

Students taking only the Scuba Training course make a $30.00 deposit (non-returnable) to the Consortium, Office of the Director, Stockton State College, Pomona, New Jersey 08240, postmarked no later than April 20, 1971. The remainder of the fee is payable to the Consortium upon arrival for the course.

Students wishing to take Credit Courses should register in person at a member college on April 22, 1971. Course conflicts will be resolved April 23, 1971.

Faculty are drawn from both the member institutions (eight colleges at the present time) as well as other colleges and universities along the Atlantic seaboard.

To obtain further information, address all inquiries directly to:

New Jersey Marine Sciences Consortium
Office of Executive Director
Richard Stockton State College
Pomona, New Jersey 08240

## THE NEW YORK OCEAN SCIENCE LABORATORY
MONTAUK, NEW YORK

The New York Ocean Science Laboratory is operated by Affiliated Colleges and Universities, Inc., a consortium of eight institutions. These are: Adelphi, Fordham, Hofstra, Long Island, New York and St. John's, New York Institute of Technology, and the State University of New York. It is a separate corporation and although it does not offer academic credit nor degrees, research work and formalized courses offered at the Laboratory may be applicable towards a degree at the member institutions. The Laboratory has its own cadre of scientists, research assistants, and technicians. Our research efforts are augmented by the staffs of the participating institutions as well as the professional and scientific personnel of cooperating industrial concerns.

The Laboratory is located at the former Torpedo and Submarine School at Fort Pond Bay in Montauk. The size, location, and accommodations of the various buildings, with more than 300,000 square feet of available floor space, makes them ideally suited for an oceanology complex. A 400-foot pier with a 40-foot draft at mean low tide, 5 railroad sightings, a sea plane station, and a helicopter pad add to the qualifications of the site. Affiliated Colleges and Universities have presently converted 30,000 square feet into research and teaching stations and plan to continue extending these facilities to meet the ever-increasing demands for research in oceanology and related fields. The present buildings accommodate the follcwing individual laboratories: General chemistry, Organic chemistry, Inorganic chemistry, Phytoplankton microbiology, Zooplankton microbiology, Invertebrate physiology, Vertebrate physiology, Botanical physiology, Data Processing, Electronics, and Physical oceanography.

In addition, there is a library equipped with three types of readers for cartridge, reel, and plate microfilm, and a large maintenance shop, sterilization room, ecological chambers, and stock rooms. Among the vessels used by the Laboratory is a 65-foot R/V KYMA, under contract, with a fully-equipped laboratory; four Boston whalers, one of which has electronic equipment which records various parameters, such as turbidity, acidity, salinity, rate of currents, etc.; and a 22-foot (with a 7-foot beam) rescue vessel equipped with a 500-horse inboard/outboard motor. Presently under construction are a sea water laboratory, a fishery laboratory, a pressure chamber laboratory, and a research museum.

M.S. and Ph.D. programs are offered at the member institutions.

For courses offered, see the descriptions of the member institutions.

The instructional staff for the courses listed abcve consists of the following:

Alexander, James, Ph.D., Senior research scientist in Chemistry
Baiardi, John C., Ph.D., President and Senior research scientist in Physiology
D'Agostino, Anthony, Ph.D., Adjunct Associate research scientist in Invertebrate Zoology
Fisher, Steve, M.S., Research Associate in Chemistry
Hickey, Clarence, M.A., Research Associate in Physiology
Hollman, Rudolph, Ph.D., Associate Research scientist in Physical Oceanography
Hunt, James, B.M.E., Senior Research scientist in Engineering
Nuzzi, Robert, Ph.D., Assistant Research scientist in Microbiology

To obtain further information, address all inquiries directly to:

Dr. John C. Baiardi, President
New York Ocean Science Laboratory
P.O. Box 867
Montauk, New York 11954

## THE RESEARCH INSTITUTE OF THE GULF OF MAINE
PORTLAND, MAINE

The Research Institute of the Gulf of Maine (TRIGOM) was incorporated in 1968 by several colleges and the University of Maine to help coordinate research and education in the ocean sciences on a statewide basis.

Funded by state appropriations and research grants from the private sector, consortium activities fall into three general categories:

RESEARCH: To coordinate and engage in mission-oriented marine research, particularly in the kinds of projects demanding broad interdisciplinary efforts.

INFORMATION: To act as a central "clearinghouse" for information serving both repository and generative functions.

EDUCATION: To expand and create new educational opportunities in the marine sciences through the development of consortium programs.

Academic member institutions include:

Bates College
Bowdoin College
Colby College
Maine Maritime Academy
University of Maine at Orono
University of Maine at Portland-Gorham
Southern Maine Vocational Technical Institute
Nasson College
Saint Francis College

Associate member institutions include:

Maine Department of Sea and Shore Fisheries
Research Department of the Maine Medical Center

In addition to the facilities available at member campuses, the consortium recently erected and equipped a field station on the Casco Bay campus of Southern Maine Vocational Technical Instiute. The laboratory is equipped with running seawater and specialized bioassay equipment, providing increased opportunities for joint projects between TRIGOM's in-house research team and the faculty and students of affiliate institutions.

A description of course offerings at those member institutions offering degree programs can be found elsewhere in this publication. Please contact these institutions directly for greater detail.

For additional information about the activities of the Institute, please write directly to:

Dr. Donald B. Horton
Executive Director
TRIGOM
96 Falmouth Street
Portland, Maine 04103

# *CURRICULA IN*

# *OCEAN ENGINEERING*



445-776 O - 71 - 10

## UNIVERSITY OF ALASKA
### COLLEGE, ALASKA

(For a description of the facilities and the marine sciences program at the University of Alaska, please refer to the University's listing in the Marine Sciences section of this publication.)

The University offers the M.S. degree in Ocean Engineering.

The program is coordinated by an interdisciplinary committee of the University composed of selected staff members from the academic colleges and research institutes involved in ocean science. At the M.S. level, the program emphasizes ocean-related course work in ocean engineering. However, additional graduate courses are recommended in the area of the student's undergraduate training to assure a high level of competence.

The minimum credit requirements for the M.S. degree are 30 graduate credits (nine of which may be thesis credits). One summer of approved field work may be substituted for a thesis. Course requirements--OCN 620, OCE 670, OCE 672, OCE 674, and OCE 680, and a minimum of six credits of additional course work to be selected by the student's committee.

The following courses are offered in conjunction with this program:

ELECTRICAL ENGINEERING

| | | |
|---|---|---|
| E.E. 693 | Special Topics (Instrumentation) | arr. |
| E.E. 694 | Special Topics (Electronics) | arr. |

ENGINEERING MANAGEMENT

| | | |
|---|---|---|
| E.M. 605 | Advanced Engineering Economy | 3 |
| E.M. 611 | Engineerine Management | 3 |
| E.M. 612 | Engineering Management | 3 |
| E.M. 613 | Engineering Management | 3 |

CIVIL ENGINEERING

| | | |
|---|---|---|
| C.E. 603 | Arctic Engineering | 3 |
| C.E. 620 | Civil Engineering Construction | 3 |
| C.E. 631 | Advanced Structural Analysis | 3 |
| C.E. 632 | Advanced Structural Design | 3 |
| C.E. 644 | Hydraulic Engineering | 3 |
| OCE 670 | Waves and Tides | 3 |
| OCE 672 | Underwater Acoustics | 3 |
| OCN 674 | Environmental Hydrodynamics | 3 |
| OCE 676 | Coastal Engineering | 3 |
| OCE 680 | Ocean Engineering Field Work | 3 |

The University also offers graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Behlke, Charles E., Ph.D., Dean of College of Mathematics, Physical Sciences and Engineering; Professor of Engineering
Kinney, Patrick J., Ph.D., Associate Professor of Marine Science; Chemical Engineering
McKay, Alexander R., M.S., Associate Professor of Mechanical Engineering; Institute of Arctic Environmental Engineering
Sackinger, William M., Ph.D., Assistant Professor of Electrical Engineering; Institute of Arctic Environmental Engineering

To obtain further information, address all inquiries directly to:

Dr. Donald W. Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska 99701

## UNIVERSITY OF ARIZONA
### TUCSON, ARIZONA

(For a description of the facilities at the University of Arizona, please refer to the University's listing in the Marine Sciences section of this publication.)

The following degrees are offered:

1. Ph.D. in Geological Engineering. Candidates specializing in Ocean Engineering may obtain a Doctor of Philosophy in Geological Engineering. A suitable minor and an approved dissertation project are required by the department. The candidate will also be required to demonstrate proficiency in one foreign language and to complete approved courses in statistics and computer techniques.

2. M.S. in Geological Engineering. Candidates for a Master of Science in Geological Engineering, specializing in Ocean Engineering, will be required to complete 30 units including a thesis and to pass a final examination covering both the thesis and course work.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF MINING AND GEOLOGICAL ENGINEERING

GEOLOGICAL ENGINEERING

| | | |
|---|---|---|
| 206 | Engineering Geology | 3 |
| 208 | Ocean Engineering | 3 |
| 220 | Geophysical Exploration | 3 |
| 238 | Design of Exploration Programs | 3 |
| 399 | Seminar | 1-3 |
| 410 | Thesis | 1-8 |
| 420 | Dissertation | 1-9 |

MINING ENGINEERING

| | | |
|---|---|---|
| 231 | New Techniques in Mining | 2 |

The University also offers graduate programs in Marine Sciences which are described in the Marine Sciences section of this publication.

The instructional staff for the courses listed above consists of the following:

Abel, John F., D.Sc., Associate Professor
Lacy, Willard C., Ph.D., Professor
Peters, William C., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dr. Willard C. Lacy
Department of Mining and Geological Engineering
The University of Arizona
Tucson, Arizona 85721

## CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

Although the Institute does not have a department or option specifically devoted to the study of marine sciences, it does offer courses that cover the fundamental subjects of some important facets of marine sciences and related fields. The major facilities closely related to studies in these various disciplines include the following:

1. Hydrodynamics Laboratory. This Laboratory contains three major experimental facilities: a high-speed water tunnel, a free-surface water tunnel, and a controllable pressure launching tank.
2. Hydraulics and Water Resources Laboratory. The major facilities in this laboratory include: Four recirculating tilting flumes for research in open-channel flow, tsunami waves, density currents and sediment transport; two fixed flumes; a wave basin for harbor studies; a low-turbulence water tunnel; and a special wave tank for impulsive wave studies. Another ocean-wave laboratory in nearby Azusa houses a large wave basin suitable for ocean wave and harbor studies.
3. W.M. Keck Laboratory of Environmental Engineering. A part of current research in this laboratory is devoted to marine science such as: mixing of stratified fluids in oceans, ecology of nearshore waters, and marine microbiology. This laboratory has well-equipped facilities and instruments for research in these areas.
4. W.H. Booth Computing Center. This Computing Center offers a comprehensive, integrated set of facilities for the research and educational use of all divisions of the Institute. The important system modes of operation include an IBM 360/75 and an IBM 360/44 computer.

No specific degrees in Marine Sciences, Hydrodynamics, Hydraulics, Ocean Engineering, or Naval Architecture are given. However, students working in fields related to marine sciences may select enrollment and obtain degrees of Bachelor of Science, Master of Science or Doctor of Philosophy in Applied Mechanics, Civil Engineering, Engineering Science, Environmental Engineering Science, or Mechanical Engineering (all of which are in the Division of Engineering and Applied Science). These degrees are subject to Institute-wide degree regulations.

The following graduate courses are offered in conjunction with the above programs:

AERONAUTICS

| | | |
|---|---|---|
| Ae 236 | Rotating and Stratified Fluids | 9 |

APPLIED MATHEMATICS

| | | |
|---|---|---|
| AMa 152 abc | Linear and Nonlinear Wave Propagation | 9 |

APPLIED MECHANICS

| | | |
|---|---|---|
| AM 175 abc | Advanced Dynamics | 9 |

ENGINEERING SCIENCE

| | | |
|---|---|---|
| ES 204 abc | Hydrodynamics of Free Surface Flows | 9 |

ENVIRONMENTAL ENGINEERING SCIENCE

| | | |
|---|---|---|
| Env 112 ab | Hydrologic Transport Processes | 9 |
| Env 142 ab | Applied Chemistry of Natural Water Systems | 9 |
| Env 145 ab | Environmental Biology | 10 |
| Eng 214 abc | Advanced Environmental Fluid Mechanics | 9 |

HYDRAULICS

| | | |
|---|---|---|
| Hy 101 abc | Fluid Mechanics | 9 |
| Hy 106 | Experimental Hydraulics and Similitude | 9 |
| Hy 111 | Fluid Mechanics Laboratory | 6-9 |
| Hy 113 | Coastal Engineering | 9 |
| Hy 121 | Advanced Hydraulic Laboratory | 6-up |
| Hy 210 ab | Hydrodynamics of Sediment Transportation | 9 |
| Hy 213 | Advanced Coastal Engineering | 9 |

MECHANICAL ENGINEERING

| | | |
|---|---|---|
| Me 126 | Fluid Mechanics and Heat Transfer Laboratory | 9 |

The Institute also offers undergraduate and graduate programs in marine science which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Brooks, Norman H., Ph.D., Professor of Environmental Science and Civil Engineering
Caughey, Thomas K., Ph.D., Professor of Applied Mechanics
Housner, George W., Ph.D., Professor of Civil Engineering and Applied Mechanics
Hudson, Donald E., Ph.D., Professor of Mechanical Engineering and Applied Mechanics
Iwan, Wilfred D., Ph.D., Associate Professor of Applied Mechanics
Lees, Lester, M.S., Professor of Environmental Engineering and Aeronautics
List, Ericson J., Ph.D., Assistant Professor of Environmental Engineering Science
Morgan, James J., Ph.D., Professor of Environmental Engineering Science
North, Wheeler J., Ph.D., Professor of Environmental Science
Sabersky, Rolf H., Ph.D., Professor of Mechanical Engineering
Saffman, Philip G., Ph.D., Professor of Applied Mathematics
Shair, Fredrick H., Ph.D., Associate Professor of Chemical Engineering
Vanoni, Vito A., Ph.D., Professor of Hydraulics
Welch, David F., I.D., Associate Professor of Engineering Design
Whitham, Gerald B., Ph.D., Professor of Applied Mathematics
Wu, Theodore Y-T., Ph.D., Professor of Engineering Science
Zukoski, Edward E., Ph.D., Professor of Jet Propulsion

To obtain further information, address all inquiries directly to:

Professor Francis Clauser
Chairman, Division of Engineering and
Applied Science
California Institute of Technology
Pasadena, California 91109

## UNIVERSITY OF CALIFORNIA
### BERKELEY, CALIFORNIA

Facilities for research within the University are located on the Berkeley campus and the nearby Richmond Field Station located on the shores of San Francisco Bay. Oceanographic research vessels are available in the bay area through working arrangements with the U. S. Geological Survey and the U. S. Bureau of Mines and in San Diego through the marine facilities of the Scripps Institution of Oceanography. The following is a partial listing of the facilities associated with the Berkeley campus:

Hydraulic Engineering Laboratory-deep wave channel; wind-wave tank, basin, and channel; wave and towing tank; model basins; sediment samplers; electronic analog-to-digital converter (HYDRA system).

Naval Architecture Laboratory-model towing tank; ship impact machine; ship structure test machine.

Sanitary Engineering Research Laboratory-treatment and reclamation of industrial and domestic wastes; apparatus for study of water pollution problems related to radioactive wastes, water resources, and air pollution.

Sea Water Conversion Laboratory-experimental unit for demineralizing sea water through solar distillation, electrodialysis, reverse osmosis, ion exchange methods.

Soil Mechanics Laboratory-strength testing with universal testing machine (four million ton capacity); strain loading machine; triaxial compression cells; shaking table; earthquake loading machine; 8-channel oscillograph.

Structural Engineering Materials Laboratory-study behavior under load of structures and models using elastic displacement, strain measurement, moire-effect, and photoelastic methods; control rooms provide wide range of temperature and humidity parameters.

Joint cooperation with the U.S. Bureau of Mines Marine Technology Center, Tiburon, U.S. Corps of Engineers Bay Model, Sausalito, and U.S. Geological Survey Pacific Coast Marine Geology, Menlo Park round out extensive research facilities available to the Ocean Engineering student.

No one particular engineering discipline includes all the ramifications of Ocean Engineering. As a consequence, there is no Department of Ocean Engineering, and no degree in Ocean Engineering as such is granted. Ocean Engineering is a graduate option in several of the established departments in the College of Engineering. Students specializing in Ocean Engineering may obtain either a scientific or a professional degree, depending on the emphasis of the program they pursue. The degrees, Master of Science and Doctor of Philosophy in Engineering or Engineering Science, are granted upon completion of programs emphasizing theory, research, and design; the professional degrees, Master of Engineering and Doctor of Engineering, are granted upon completion of programs emphasizing economic and technical problems arising in the professional practice of engineering.

The Ocean Engineering Program within the College of Engineering includes the following departments: Civil Engineering, Materials Science and Engineering, Mechanical Engineering, and Naval Architecture. The Institute of Marine Resources sponsors research in inorganic marine resources, chiefly on the chemical and geological properties of ocean-bottom sediments in cooperation with the Ocean Engineering Program.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

DEPARTMENT OF CIVIL ENGINEERING

| | | |
|---|---|---|
| CE 201A | Physical Oceanology | 3 |
| CE 201B | Chemical Oceanology | 3 |
| CE 201C | Geological Oceanology | 3 |
| CE 205A | Coastal Engineering | 3 |
| CE 205B | Coastal Engineering | 3 |
| CE 206A | River Hydraulics and Sedimentation | 3 |
| CE 206B | River Hydraulics and Sedimentation | 3 |
| CE 206C | River Hydraulics and Sedimentation | 3 |
| CE 207 | Advanced Hydraulic Design | 3 |
| CE 208 | Advanced Hydraulic-Structures Laboratory | 2 |
| CE 226 | Random Vibrations of Structural Systems | 3 |
| CE 290J | Vibration of Ship Structures | 3 |

DEPARTMENT OF ENGINEERING

| | | |
|---|---|---|
| E 298 | Ocean Engineering Seminar | 1 |

DEPARTMENT OF MECHANICAL ENGINEERING

| | | |
|---|---|---|
| AS 262 | Theoretical Hydrodynamics | 4 |
| AS 263A | Viscous Fluid Flow | 4 |
| AS 263B | Viscous Fluid Flow | 4 |
| AS 270A | Geophysical Fluid Mechanics | 3 |
| AS 270B | Geophysical Fluid Mechanics | 3 |
| AS 270C | Geophysical Fluid Mechanics | 3 |
| AS 290C | Turbulence | 4 |
| AM 283 | Wave Propagation in Elastic Media | 4 |
| AM 290C | Acoustic Wave Propagation | 3 |
| AM 290E | Selected Topics in Wave Propagation in Anelastic Materials | 4 |
| ME 164 | Engineering Aero- and Hydro-Dynamics | 3 |
| ME 290N | Corrosion | 4 |

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

| | | |
|---|---|---|
| EG 106 | Applied Geophysics | 3 |
| EG 202A | Random Models for Geophysical Phenomena | 3 |
| EG 202B | Random Models for Geophysical Phenomena | 3 |
| EG 206 | Electrical, Magnetic, and Gravity Methods | 5 |
| EG 290A | Geophysical Measurements and Instruments | 3 |

DEPARTMENT OF NAVAL ARCHITECTURE

| | | |
|---|---|---|
| NA 240A | Theory of Ship Structures | 3 |
| NA 240B | Theory of Ship Structures | 3 |
| NA 240C | Theory of Ship Structures | 3 |
| NA 241A | Hydrodynamics of Ships | 3 |
| NA 241B | Hydrodynamics of Ships | 3 |
| NA 241C | Hydrodynamics of Ships | 3 |
| NA 242 | Advanced Ship Design | |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL ENGINEERING

Clough, R. W., Jr., Sc.D., Professor, Civil Engineering
Duncan, J. M., Ph.D., Assistant Professor of Civil Engineering
Einstein, H. A., D.S.T., Professor of Hydraulic Engineering
Fischer, H. B., Ph.D., Assistant Professor of Hydraulic Engineering
Johnson, J. W., M.S., Professor of Hydraulic Engineering, Director of Hydraulic Engineering Laboratory
Kaufman, W. J., Professor of Sanitary and Radiological Engineering, Director of Sanitary Engineering Research Laboratory
Lin, T. Y., M.S., Professor of Civil Engineering
Lysmer, J., Ph.D., Assistant Professor of Civil Engineering
Mason, D. T., Ph.D., Assistant Professor of Sanitary Engineering
McGauhey, P. H., M.S., Professor of Sanitary Engineering and Public Health, Emeritus
Mitchell, J. K., Sc.D., Associate Professor of Civil Engineering
Moffitt, F. H., M.C.E., Professor of Civil Engineering
Oswald, W. J., Ph.D., Professor of Sanitary Engineering
Pearson, E. A., Sc.D., Professor of Sanitary Engineering, Chairman, Division of Hydraulic and Sanitary Engineering
Penzien, J., Sc.D., Professor Civil Engineering
Seed, H. B., Ph.D., Professor of Civil Engineering, Chairman, Department of Civil Engineering
Selleck, R. E., Ph.D., Associate Professor of Sanitary Engineering
Thomas, J. F., Ph.D., Professor of Sanitary Engineering
Wiegel, R. L., M.S., Professor of Civil Engineering
Wilde, P., Ph.D., Assistant Professor of Hydraulic Engineering and Research Oceanographer, Institute of Marine Resources
Witherspoon, P. A., Ph.D., Professor of Geological Engineering

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Fuerstenau, D. W., Sc.D., Professor of Metallurgy
Morrison, H. F., Ph.D., Associate Professor of Geophysical Engineering
Rodgers, P., Ph.D., Assistant Professor of Geophysical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Corcos, G. M., Ph.D., Professor of Aeronautical Sciences
Cornet, I., Ph.D., Professor of Mechanical Engineering
Holt, M., Ph.D., Professor of Aeronautical Sciences
Howe, E. D., M.S., Professor of Mechanical Engineering, Emeritus
Laird, A. D. K., Ph.D., Professor of Mechanical Engineering, Director of Sea Water Conversion Laboratory
Laitone, E. V., Ph.D., Professor of Aeronautical Sciences
Sherman, F. S., Ph.D., Professor of Aeronautical Sciences
Spiegler, K. S., Ph.D., Professor of Mechanical Engineering

DEPARTMENT OF NAVAL ARCHITECTURE

Paulling, J. R., Jr., D.Eng., Professor of Naval Architecture
Schade, H. A., Dr.Ing., Professor of Naval Architecture, Emeritus
Sibul, O. J., M.S., Lecturer in Naval Architecture
Webster, W. M., Ph.D., Acting Associate Professor of Naval Architecture
Wehausen, J. V., Ph.D., Professor of Engineering Science, Chairman, Department of Naval Architecture

To obtain further information, address all inquiries directly to:

Professor P. Wilde, Chairman
Committee on Engineering in the Ocean Environment
College of Engineering
University of California
Berkeley, California 94720

## THE CATHOLIC UNIVERSITY OF AMERICA
WASHINGTON, D. C.

The Institute of Ocean Science and Engineering was established at the University in 1967 to foster research and academic programs in the marine sciences. The major areas of marine related research are: underwater acoustics, properties of transducers, structure and physical properties of salt water, marine cables, instrumentation, fluid dynamics, soil mechanics, and physical properties of water laboratories. The University has participated in a cooperative program with three local Naval laboratories since 1967. This program sponsors mutual use of research facilities and oceanographic ships. Computer facilities include IBM 1620 and 1130 computers and a PDP-10 computer. The University is a member of the Washington Consortium of Universities and The Marine Science Consortium of Pennsylvania Colleges and Universities. The University offers undergraduate and graduate programs at its main campus in northeast Washington, D.C. and at the "Delaware Bay Marine Science Center" of the Marine Science Consortium in Lewes, Delaware.

The following degrees are offered in ocean engineering and related fields:

1. D. Engr. or Ph.D. in Ocean Engineering (Department of Civil and Mechanical Engineering). Candidates for the Doctorate in Ocean Engineering must satisfactorily complete two years of full-time resident graduate study beyond the Master's degree, or its equivalent on a part-time or three-quarter time basis. Degree requirements may be summarized as follows: a major course program (a minimum of 35 credit hours beyond the Bachelor's degree), 18 credit hours in a minor field (usually mathematics) or 12 credit hours in a first minor field and 6 credit hours in a second minor field, written comprehensive examinations in the major and first minor fields, a reading knowledge of one foreign language, a dissertation, and an oral defense of dissertation. Doctoral programs in Ocean Engineering are tailored

to meet the needs of the individual student. Candidates may specialize in Fluid or Solid Mechanics, Heat Transfer or Thermodynamics, Control System, or Underwater Acoustics. All doctoral candidates in Ocean Engineering must take a minimum of nine credit hours in pure or applied oceanography, six one-semester upper-level graduate courses in their specialty area, and acquire appropriate at-sea experience.

2. M.S.E. in Ocean Engineering (Department of Civil and Mechanical Engineering). Candidates for the degree of Master of Science in Ocean Engineering are required to satisfactorily complete one year of full-time graduate study (a minimum of 24 credit hours including research and seminars), or its equivalent or a part-time or three-quarter time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Ocean Engineering would consist of Inviscid Incompressible Flow, Ocean Engineering, Ocean Waves, Materials for the Ocean and Other Extreme Environments, and Structural Mechanics I and II.

3. D. Engr. or Ph.D. in Engineering Acoustics (Department of Civil and Mechanical Engineering). Candidates for the Doctorate in Engineering Acoustics must satisfactorily complete two years of full-time resident graduate study beyond the Master's degree, or its equivalent on a part-time or three-quarter time basis. Degree requirements may be summarized as follows: a major course program (a minimum of 35 credit hours beyond the Bachelor's degree), 18 credit hours in a minor field (usually mathematics) or 12 credit hours in a first minor field and six credit hours in a second minor field, written comprehensive examinations in the major and first minor fields, a reading knowledge of one foreign language, a dissertation, and an oral defense of the dissertation. Doctoral programs in Engineering Acoustics are tailored to meet the needs of the individual students who may specialize in either underwater, theoretical, statictical, or physical acoustics. However, the following courses are required of all doctoral candidates: Radiation and Scattering I and II, Vibrations of Elastic Solids.

4. M.S.E. in Engineering Acoustics (Department of Civil and Mechanical Engineering). Candidates for the degree of Master of Science in Engineering (Acoustics) are required to satisfactorily complete one year of full-time graduate study (a minimum of 24 credit hours including research and seminars), or its equivalent on a part-time or three-quarter time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Engineering Acoustics would consist of Introduction to Acoustics, Continuum Mechanics, Random Signal Theory I, Theory of Waves, Experimental Dynamics Laboratory, and one elective in the major field.

5. B.S.E. (Ocean Engineering Option) (Department of Civil and Mechanical Engineering). Undergraduate students in this program follow the same curriculum as other mechanical engineering students during the freshman and sophomore years. Required Ocean Engineering courses in the junior and senior year are Engineering Properties of Materials, Physical Oceanography, and Dynamic Measurements. The other required courses follow the C.M.E. curriculum. Projects related to Ocean Engineering are included in the laboratory and design courses. Fifteen semester hours of electives in the senior year may be selected from the list of mechanical and ocean engineering courses at the senior and the beginning graduate level.

The following courses are offered in conjunction with the above programs:

## GRADUATE COURSES

### DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

| | | |
|---|---|---|
| 501 | Structural Mechanics I | 3 |
| 502 | Structural Mechanics II | 3 |
| 503 | Introduction to Continuum Mechanics | 3 |
| 504 | Physical Oceanography | 3 |
| 505 | Advanced Design | 3 |
| 506 | Advanced Design | 3 |
| 507 | Introduction to Ocean Engineering | 3 |
| 508 | Ocean Waves | 3 |
| 509 | Materials for Ocean and Other Extreme Environments | 3 |
| 511 | Limit Analysis of Structures | 2 |
| 512 | Structural Analysis | 3 |
| 514 | Geological Oceanography | 3 |
| 515 | Structural Dynamics | 3 |
| 517 | Fundamentals of Instrumentation | 3 |
| 532 | Experimental Dynamics Laboratory | 3 |
| 534 | Experimental Stress Analysis | 3 |
| 541 | Classical Mechanics | 3 |
| 545 | Foundation of Fluid Mechanics | 3 |
| 546 | Inviscid Incompressible Flows | 3 |
| 547 | Inviscid Compressible Flows | 3 |
| 548 | Incompressible Viscous Flows | 3 |
| 554 | Applied Underwater Acoustics | 3 |
| 561 | Heat Transfer | 3 |
| 562 | Heat Transfer | 3 |
| 564 | Theory of Waves | 3 |
| 565 | Control System Analysis and Synthesis | 3 |
| 566 | Control System Analysis and Synthesis | 3 |
| 568 | Electromechanical Circuits and Transducers | 2 |
| 571 | Theoretical Thermodynamics | 3 |
| 572 | Theoretical Thermodynamics | 3 |
| 581 | Introduction to Acoustics | 3 |
| 582 | Environmental Noise and its Control | 2 |
| 597 | Seminar | 1 |
| 598 | Seminar | 1 |
| 701 | Design of Complex Systems | 3 |
| 702 | Design of Complex Systems | 3 |
| 704 | Theory of Plasticity | 2 |
| 705 | Theory of Shells and Plates | 3 |
| 706 | Nonlinear Elasticity | 3 |
| 707 | Propagation of Sound in the Sea | 3 |
| 708 | Theoretical Elasticity | 3 |
| 709 | Radiation and Scattering I | 3 |
| 710 | Radiation and Scattering II | 3 |
| 712 | Acoustic Signal Processing | 3 |
| 715 | Discrete Time Systems | 3 |
| 716 | Discrete Time Systems | 3 |
| 718 | Stability of Structures | 3 |
| 733 | Viscous Gas Dynamics | 3 |
| 734 | Separation of Flow | 3 |
| 735 | Experimental Stress Analysis II | 3 |
| 736 | Experimental Stress Analysis III | 3 |
| 741 | Vibrations in Elastic Solids | 3 |
| 742 | Acoustic Radiation from Submerged Structures | 3 |
| 743 | Hypersonic Gas Dynamics | 3 |

| | | |
|---|---|---|
| 744 | Hypersonic Gas Dynamics | 3 |
| 757 | Optimal Control Systems | 3 |
| 758 | Optimal Control Systems | 3 |
| 761 | Conduction Heat Transfer | 3 |
| 762 | Radiation Heat Transfer | 3 |
| 763 | Stochastic Control Theory | 3 |
| 764 | Adaptive Control and Learning Systems | 3 |
| 768 | Propagation in Random Media | 3 |
| 797 | Research | 3 |
| 798 | Research | 3 |
| 995 | Master's Dissertation Guidance | 0 |
| 996 | Master's Dissertation Guidance | 0 |
| 997 | Doctoral Dissertation Guidance | 0 |
| 998 | Doctoral Dissertation Guidance | 0 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Andrews, Frank A., Ph.D., Professor of Acoustics
Casarella, Mario J., Ph.D., Associate Professor of Ocean Engineering
Chang, Paul K., Ph.D., Professor of Fluid Mechanics
Chi, Michael, Ph.D., Professor of Structural Mechanics
Curran, Henry M., Ph.D., Associate Professor of Systems Engineering
Didion, David A., M.M.E., Assistant Professor of Heat Transfer
Durelli, August J., Ph.D., Professor of Stress Analysis
Gilheany, John J., Ph.D., Associate Professor of Ocean Engineering
Heller, Samuel R., Ph.D., Professor and Chairman of Civil and Mechanical Engineering (Ocean Engineering)
Jackson, Francis J., Ph.D., Adjunct Professor of Acoustics
Kelnhofer, William J., Ph.D., Associate Professor of Fluid Mechanics
Khatri, Hiralal C., Ph.D., Associate Professor of Systems Engineering
Magrab, Edward B., Ph.D., Associate Professor of Acoustics
Parks, Vincent J., Ph.D., Associate Professor of Stress Analysis
Perrone, Nicholas, Ph.D., Adjunct Professor of Structural Mechanics
Smith, Russell A., Ph.D., Associate Professor of Fluid Mechanics
Soteriades, Michael C., Ph.D., Professor of structural Mechanics
Spooner, Ronald, Ph.D., Adjunct Professor of Acoustics
Thiruvengadam, Alagupillai, Ph.D., Associate Professor of Ocean Engineering
Tsao, Chi-Kung, Ph.D., Associate Professor of Heat Transfer
Vaishnav, Ramesh N., Ph.D., Professor of Structural Mechanics

DEPARTMENT OF AEROSPACE AND ATMOSPHERIC SCIENCES

Atabek, Bulent H., Ph.D., Professor of Fluid Mechanics
Chang, Chieh C., Ph.D., Professor and Chairman of Aerospace and Atmospheric Sciences (Atmospheric Vortices)
Eisler, Thomas J., Ph.D., Professor of Acoustics
Kao, Timothy W., Ph.D., Professor of Geophysical Fluid Mechanics
Lee, Kai, F., Ph.D., Associate Professor of Atmospheric Physics
Ling, Sung C., Ph.D., Professor of Fluid Mechanics
Pao, Hsien P., Ph.D., Professor of Geophysical Fluid Mechanics
Rispin, Paul, Ph.D., Assistant Professor of Hydrodynamics
Wang, Duen-Pao, Ph.D., Associate Professor of Hydrodynamics
Whang, Yun C., Ph.D., Professor of Fluid Mechanics

To obtain further information, address all inquiries directly to:

Dr. John J. Gilheany
Institute of Ocean Science and Engineering
Catholic University of America
Washington, D.C. 20017

## THE UNIVERSITY OF DELAWARE
### NEWARK, DELAWARE

Ocean Engineering courses are offered both at the main campus in Newark and the Marine Laboratory's field station at Lewes, Delaware. On-campus laboratory facilities are located primarily within the departments of Civil and Mechanical and Aerospace Engineering. The fluid mechanics laboratory contains a combined towing and wave tank with 8 foot by 5 foot test section, a free surface hydrodynamic tank with 4 foot by 6 foot test section, a rotating flow table and a small wave tank. High speed cameras and hydrogen bubble generators used for flow visualization are among the specialized equipment available

The environmental engineering laboratories are equipped for chemical and biological analysis of water. Specialized equipment includes stability indicator, turbidimeter, BOD apparatus, Kjeldahl N apparatus, spectrophotometer, polargraph, rotary viscometer, Warburg respirator, and a D.O. probe accruate to one part per billion of dissolved oxygen.

Well equipped soil mechanics, metallurgical, and structural laboratories are also available for marine-oriented research. Field research and instruction in coastal and oceanographic engineering are conducted at the Lewes field station using classrooms, laboratories, and vessels located there.

The University offers the following degrees:

1. Bachelor of Civil Engineering - with specialization in ocean engineering (Department of Civil Engineering). All students are required to complete the basic civil engineering curriculum requiring 134 semester hours of course credit. This includes 112 hours of required course work and allows 18-22 hours of technical electives which may be devoted to marine-related courses or special projects. Similar B.S. degree programs exist in Chemical Engineering, Electrical Engineering, and Mechanical and Aerospace Engineering (but with fewer technical electives).
2. Master of Civil Engineering - with specialization in ocean engineering. This program requires that a student complete 30 credit hours of graduate study beyond the bachelor's degree of which 24 are in course work plus six hours of thesis. Considerable

flexibility is available to permit a student to formulate a program suited to his specific interests. Similar programs exist in the other engineering departments.

3. Ph.D. in Applied Science - with specialization in ocean engineering. Essentially 72 semester credits beyond the bachelor's degree are required including approximately 24 credits in the major area, 24 credits in the areas of mathematics, physical and engineering science, and 24 credits in thesis research. A broad range of programs can be arranged to fit the student's particular research interests.

Ocean engineering is an interdisciplinary program sponsored on an interdepartmental basis by the College of Engineering. At present most marine-related courses are offered by the Department of Civil Engineering but with other departments (i.e., Chemical, Electrical, and Mechanical and Aerospace) prepared to assist students in formulating programs in their area of specialization, and to provide appropriate special problem studies.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| CE 671 | Ocean Engineering I | 3 |
| CE 672 | Ocean Engineering II | 3 |
| CE 673 | Engineering in a Coastal Environment | 3 |
| CE 674 | Coastal and Estuarine Geotechnique | 3 |
| CE 675 | Marine Soils Engineering | 3 |
| CE 837* | Mechanics of Free Surface Flow | 3 |
| CE 839 | Applied Hydraulics | 3 |
| CE 866 | Special Problems | 1-6 |
| CE 871 | Marine Structures I (Floating) | 3 |
| CE 872 | Marine Structures II (Fixed) | 3 |
| CE 873* | Marine Transportation Systems | 3 |
| CE 874 | Geophysical Fluid Mechanics | 3 |
| G 220 | Meteorology | 3 |
| GEO 631 | Marine Geology | 3 |
| GEO 637 | Geology of Recent Sedimentary Environments | 3 |
| MAE 622 | Introduction to Stability and Control | 3 |
| MAE 633 | Hydromechanics | 3 |
| MAE 833 | Fluid Mechanic Stability | 3 |
| MET 611 | Corrosion and Corrosion Control | 3 |

*Available upon sufficient student demand.

The University also offers undergraduate and graduate programs in marine science which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL ENGINEERING

Boyer, Don L., Ph.D., Associate Professor of Civil, Mechanical and Aerospace Engineering
Camfield, Frederick E., Ph.D., Assistant Professor of Civil Engineering and Marine Studies
Preslan, William L., Instructor of Civil Engineering
Wang, Hsiang, Ph.D., Associate Professor of Civil Engineering and Marine Studies

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Greenberg, Michael D., Ph.D., Assistant Professor of Mechanical and Aerospace Engineering
Seidel, Barry S., Sc.D., Professor of Mechanical and Aerospace Engineering

To obtain further information, address all inquiries directly to:

Dr. Hsiang Wang
College of Engineering
University of Delaware
Newark, Delaware 19711

## FLORIDA ATLANTIC UNIVERSITY
### BOCA RATON, FLORIDA

Florida Atlantic University offers courses in Ocean Engineering and Marine Sciences on its campus at Boca Raton in southeast Florida. Ocean Engineering laboratories and workshops are provided on campus. Two boats are available for research and instructional use at sea. When needed, larger work boats or ships are chartered for special projects. The Department, which started in September 1965, has established liaison with ocean engineering industry, government and private laboratories where students in the regular and Cooperative Work/Study Programs perform the professional development phases of thier programs. The Department offers a Cooperative Work/Study Program as part of the National Sea Grant Program that provides on-the-job experience for ocean engineering students in industry and government laboratories as part of their educational program at Florida Atlantic University.

The following degrees are offered:

1. M.S. in Engineering with major in Ocean Engineering. The Department of Ocean Engineering offers programs of graduate study leading to a masters degree in ocean engineering. A thesis option requires a minimum of 45 credits of work, including a thesis, and provides a Master of Science in Engineering degree. The non-thesis option requiries a minimum of 54 credits of work and leads to a Master of Engineering degree. Students may specialize in areas such as oceanographic processes, materials and corrosion, underwater communications and acoustics, ocean structures or other subspecialties of their choosing if programs acceptalbe to their graduate committee can be constructed form course offerings and facilities available.

At least one-half of all graduate work must be 600 level courses. The balance may be either undergraduate, 500 or 600 level, as approved by the student's advisory committee. Students who enter the graduate program from undergraduate curricula which do not provide an engineering background or adequate preparation for required graduate courses will be expected to complete additional undergraduate courses for which no graduate credit may be received.

2. B.S. in Engineering with major in Ocean Engineering. The Department of Ocean Engineering provides a comprehensive, practical undergraduate curriculum in science and engineering which will prepare the student to perform engineering in the ocean. Graduates of this program are prepared for graduate studies in Ocean Engineering and for professional positions in industry and govern-

ment.

As Florida Atlantic University is an upper division university, it admits students at the junior year level. The program requires a firm foundation in English composition and grammer, mathematics, chemistry and physics at the lower division level, plus courses in the social sciences and humanities for a balance educational background for the engineering profession. These are provided in the pre-engineering or pre-ocean engineering (university parallel) programs of junior colleges and the lower division pre-engineering programs of most four year colleges.

The Ocean Engineering program includes intergrated courses encompassing basic engineering sciences and mathematics; study of the ocean environment and its relationship to other sciences and engineering; processing of ocean engineering data; and the application of these elements to the solution of engineering problems connected with work in or on the ocean and in developing the resources of the oceans.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

DEPARTMENT OF OCEAN ENGINEERING

UNDERGRADUATE

CORE COURSES

| | | |
|---|---|---|
| OCEN 401 | Engineering Materials I | 3 |
| OCEN 402 | Engineering Materials II | 3 |
| OCEN 404 | Physical Oceanography | 3 |
| OCEN 405 | Chemical Oceanography | 3 |
| OCEN 406 | Geological Oceanography | 3 |
| OCEN 412 | Mechanical Vibrations | 3 |
| OCEN 420 | Acoustics | 3 |
| OCEN 421 | Transducer Design | 3 |
| OCEN 425 | Statics | 4 |
| OCEN 426 | Dynamics | 4 |
| OCEN 429 | Fluid Mechanics I | 3 |
| OCEN 430 | Fluid Mechanics II | 4 |
| OCEN 434 | Strength of Materials I | 3 |
| OCEN 435 | Strength of Materials II | 3 |
| OCEN 437 | Engineering Thermodynamics I | 3 |
| OCEN 438 | Engineering Thermodynamics II | 3 |
| OCEN 440 | Heat Transfer | 4 |
| OCEN 449 | Ocean Engineering Practical Work and Independent Study | 3-6 |
| OCEN 460 | Ocean Engineering Seminar | 1 |
| OCEN 462 | Design Planning and Engineering Practices | 1 |
| OCEN 463 | Ocean Influences and Perspectives | 1 |
| OCEN 464 | Introduction to Ocean Engineering | 2 |
| EE 400 | Electrical Circuit Analysis I | 4 |
| EE 401 | Electronics | 4 |
| EE 402 | Electrical Energy Conversion and Control | 3 |
| MATH 323 | Differential Equations | 4 |
| MATH 391 | Principles of Computers and Programming | 4 |
| BIOL 315 | Marine Biology for Ocean Engineers | 3 |

TECHNICAL ELECTIVES (9 credits required)

| | | |
|---|---|---|
| OCEN 422 | Underwater Sound Propagation | 3 |
| OCEN 431 | Fluid Mechanics III | 3 |
| OCEN 432 | Undewater Structures | 3 |
| OCEN 451 | Communications Theory I | 4 |
| OCEN 452 | Communications Theory II | 2 |
| OCEN 453 | Experimental Stress Analysis | 3 |
| OCEN 454 | Environmental Susceptibility of Materials | 3 |
| OCEN 480 | Design and Instrumentation Laboratory | 6 |
| EE 423 | Instrumentation | 3 |

GRADUATE

| | | |
|---|---|---|
| OCEN 500 | Soil Mechanics for Ocean Engineers | 3 |
| OCEN 600 | Sediment Properties and Near Shore Processes | 3 |
| OCEN 601 | Applied Ocean Studies | 3 |
| OCEN 610 | Wave Theory | 3 |
| OCEN 611 | Linear Systems Analysis | 3 |
| OCEN 612 | Electronic Devices and Application | 3 |
| OCEN 615 | Signal Processing | 3 |
| OCEN 621 | Advanced Acoustics I | 3 |
| OCEN 622 | Advanced Acoustics II | 3 |
| OCEN 630 | Modern Hydrodynamics | 3 |
| OCEN 640 | Advanced Heat Transfer | 3 |
| OCEN 645 | Mass Transfer | 3 |
| OCEN 646 | Experimental Stress Analysis I | 3 |
| OCEN 648 | Theory of Plates | 3 |
| OCEN 649 | Advanced Mechanics of Materials | 3 |
| OCEN 650 | Ocean Structures Analysis | 3 |
| OCEN 651 | Ocean Structure Design | 3 |
| OCEN 652 | Underwater Structural Dynamics | 3 |
| OCEN 653 | Theory of Elasticity | 3 |
| OCEN 654 | Finite Element Method for Ocean | 3 |
| OCEN 660 | Corrosion I | 3 |
| OCEN 661 | Corrosion II | 3 |
| OCEN 662 | Advanced Engineering Materials | 3 |
| OCEN 670 | Advanced Engineering Dynamics | 3 |
| OCEN 672 | Theory of Oscillations | 3 |
| OCEN 673 | Vibrations of Elastic Structures | 3 |
| OCEN 678 | Nonlinear Vibrations I | 3 |
| OCEN 690 | Directed Independent Study | 3 |
| OCEN 698 | Special Topics in Ocean Engineering | 2-6 |
| OCEN 699 | Master's Research | 2-20 |

The University also offers a graduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Brannock, Robert N., Ph.D., Associate Professor, Ocean Engineering
Case, Robert O., Ph.D., Assistant Professor, Ocean Engineering
Davidson, James B., M.S., Professor, Ocean Engineering
Dunn, Stanley E., M.S., Instructor, Ocean Engineering
Hartt, William H., Ph.D., Assistant Professor, Ocean Engineering
McAllister, Raymond F., Ph.D., Professor, Oceanography
Monroe, Frederick F., M.S., Assistant Professor, Oceanography
Murday, Mayloganaden, M.S., Instructor, Oceanography
Pohl, James H., M.S., Assistant Professor, Ocean Engineering
Stephan, Charles R., B.S., Chairman and Professor, Ocean Engineering
Tessin, William, Ph.D., Professor, Ocean Engineering
Villanueva, José, Ph.D., Associate Professor, Ocean Engineering

To obtain further information, address all inquiries directly to:

Professor Charles R. Stephan
Chairman, Department of Ocean

Engineering
Florida Atlantic University
Boca Raton, Florida 33432

## UNIVERSITY OF FLORIDA
GAINESVILLE, FLORIDA

The College of Engineering encompasses, twelve departments, the Florida Engineering and Industrial Experiment Station, and the off-campus Graduate Engineering System, an educational television network. Five of the departments (Aerospace, Civil, Coastal and Oceanographic, Environmental, and Mechanical Engineering) pursue a wide range of engineering problems related to the aquatic environments. The other departments are all engaged, to various degrees, in activities that have necessary application. An example is offered by the Department of Electrical Engineering which provides a fundamental support through independent research and cooperation with other disciplines such as the Communication Sciences Laboratory (underwater communication system) and the College of Medicine (biomedical electronics). Extensive, modern facilities are available in all the Departments.

The Fluid Mechanics Institute works toward the further development of excellence in the area of fluid mechanics both within the College of Engineering and the individual departments through the encouragement of voluntary cooperation among departments and faculty members with capabilities and interests in fluid mechanics.

The following degrees are offered:

1. Department of Aerospace Engineering Bachelor of Science in Aerospace Engineering, Master of Engineering, Master of Science in Engineering, Engineer Degree, Doctor of Philosophy.
2. Department of Chemical Engineering Bachelor of Science in Chemical Engineering, Master of Engineering, Master of Science in Engineering, Doctor of Philosophy.
3. Department of Civil Engineering Bachelor of Science in Civil Engineering, Master of Engineering, Master of Science in Engineering, Engineer Degree, Doctor of Philosophy.
4. Department of Coastal and Oceanographic Engineering Engineer Degree, Master of Engineering, Master of Science in Engineering.
5. Department of Electrical Engineering Bachelor of Science in Electrical Engineering, Master of Engineering, Master of Science in Engineering, Engineer Degree, Doctor of Philosophy.
6. Department of Environmental Engineering Master of Engineering, Master of Science in Engineering, Engineer Degree, Doctor of Philosophy.
7. Department of Mechanical Engineering Bachelor of Science in Mechanical Engineering, Master of Engineering, Master of Science in Engineering, Engineer Degree, Doctor of Philosophy.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF AEROSPACE ENGINEERING

| | |
|---|---|
| EGC 601 | Theory of Fluid Flow 1 |
| EGC 602 | Theory of Fluid Flow 2 |
| EGC 603 | Theory of Fluid Flow 3 |
| EGC 604 | Boundary Layer Theory |
| ASE 401 | Aerodynamics 1 |
| ASE 402 | Aerodynamics 2 |
| ASE 403 | Aerodynamics 3 |

DEPARTMENT OF CIVIL ENGINEERING

| | |
|---|---|
| CE 421 | Water Resources Engineering |
| CE 450 | Water Supply Engineering |
| CE 490 | Civil Engineering Seminar |
| CE 521 | Geohydrology |
| CE 622 | Open-channel Hydraulics 2 |
| CE 623 | Sediment Transport |
| CE 625 | Hydraulic Measurement in Field |
| CE 626 | Advanced Hydraulic Problems |

DEPARTMENT OF COASTAL AND OCEANOGRAPHIC ENGINEERING

| | |
|---|---|
| COE 400 | Introduction to Coastal and Oceanographic Engineering |
| COE 410 | Coastal Hydraulics |
| COE 550 | Harbor Engineering |
| COE 610 | Ocean Waves 1: Linear Theory |
| COE 611 | Ocean Waves 2: Nonlinear Theory |
| COE 612 | Ocean Wave Spectra |
| COE 613 | Long Waves and Tides |
| COE 620 | Coastal Structures 1: Theory |
| COE 621 | Coastal Structures 2: Applications |
| COE 630 | Littoral Processes |
| COE 631 | Simulation Techniques |
| COE 632 | Selected Field and Laboratory Problems |
| COE 640 | Physical Oceanography |
| COE 641 | Air-Sea Interaction 1: Micro-scale |
| COE 642 | Air-Sea Interaction 2: Macro-scale |
| COE 643 | Advanced Topics in Coastal and Oceanographic Engineering |
| COE 699 | Master's Research |

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

| | |
|---|---|
| ENE 500 | Treatment of Waste Water |
| ENE 501 | Industrial Waste Treatment |
| ENE 520 | Environmental Biology |
| ENE 522 | Environmental Engineering |
| ENE 531 | Water and Wastewater Analysis |
| ENE 534 | The Chemistry of Water Treatment |
| ENE 591 | Special Topics in Environmental Engineering 1 |
| ENE 592 | Special Topics in Environmental Engineering 2 |
| ENE 600 | Advanced Waste Treatment Operations |
| ENE 601 | Advanced Environmental Engineering Design 1 |
| ENE 602 | Advanced Evvironmental Engineering Design 2 |
| ENE 612 | Water Management Seminar |
| ENE 613 | Environmental Engineering Systems |
| ENE 614 | Advanced Water Supply Engineering |
| ENE 615 | Analysis of Water Resources Projects |
| ENE 616 | Urban Environmental Problems |
| ENE 617 | Estuarine Systems |
| ENE 626 | Aquatic Microbiology |
| ENE 627 | Biology of Aquatic Systems |
| ENE 630 | Environmental Chemistry |
| ENE 631 | Advanced Water Analysis |
| ENE 636 | Principles of Water Chemistry |
| ENE 637 | Special Topics in Water Chemistry |
| ENE 656 | Environmental Meteorology |
| ENE 668 | Man and His Environment |
| ENE 670 | Graduate Environmental Engineering Seminar |

DEPARTMENT OF MECHANICAL ENGINEERING

| | | |
|---|---|---|
| ME | 620 | Instrumentation and Measurements Laboratory |
| ME | 621 | Feedback Control System Design 1 |
| ME | 623 | Feedback Control System Design 2 |
| ME | 624 | Feedback Control System Design 3 |
| ME | 650 | Specail Topics in Fluid Dynamics |
| ME | 651 | Special Topics in Heat Transfer |
| ME | 652 | Thermodynamics of Fluid Flow 1 |
| ME | 653 | Thermodynamics of Fluid Flow 2 |
| ME | 654 | Thermodynamics of Fluid Flow 3 |
| ME | 655 | Conduction Heat Transfer |
| ME | 656 | Convective Heat Transfer 1 |
| ME | 657 | Radiation Heat Transfer |
| ME | 658 | Convective Heat Transfer 2 |
| ME | 663 | Energy Conversion |
| ME | 666 | Solar Energy Utilization |
| ME | 667 | Special Topics in Solar Energy |

The University also offers undergraduate and graduate programs in Marine Science which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF AEROSPACE ENGINEERING

Anderson, Roland Carl
Clarkson, Mark Hall
Fearn, Richard Lee
Hoover, John Wesley
Keefer, Dennis Ralph
Leadon, Bernard Matthew
McRae, Thomas Garland
Milton, James Edmund
Myers, Orlo E.
Ross, Claudius Allen
Williams, David Tyndale

DEPARTMENT OF CHEMICAL ENGINEERING

Bennett, Robert Broadhurst
Fahien, Raymond W.
Gubbins, Keith Edmund
Johns, Lewis E., Jr.
Keppel, Reuben Arthur
Kirmse, Dale William
May, Frank Pierce
Nolan, William John
O'Connell, John Paul
Reed, Thomas McKennan
Reed, X. B., Jr.
Schweyer, Herbert English
Tyner, Mack
Walker, Robert Dixon, Jr.
Westerberg, Arthur William

DEPARTMENT OF CIVIL ENGINEERING

Christensen, Bent Aksel
Collier, Courtland
Dean, Robert George
Furman, Thomas deSaussure
Grantham, William J., Jr.
Huber, Wayne Charles
Kluge, Ralph Wendel
Petryk, Sylvester
Pyatt, Edwin Eugene
Sawyer, Herbert A.
Schaub, James Hamilton
Schmertmann, John Henry
Self, Morris Waldt
Shemdin, Omar H.
Smith, Ronald Ellis
Spangler, Byron Dement
Susag, Russell Harry
Zimpfer, Walter Henry

DEPARTMENT OF COASTAL AND OCEANOGRAPHIC ENGINEERING

Dean, Robert George
Jen, Yuan
Partheniades, Emmanuel
Purpura, James Arthur
Shemdin, Omar H.
Verma, Akhileshwar Prasad

DEPARTMENT OF ELECTRICAL ENGINEERING

Bailey, Robert Leo
Bailey, Thomas Lee, III
Boykin, William Henry, Jr.
Brodersen, Arthur James
Bullock, Thomas Edward, Jr.
Chen, Wayne H.
Chenette, Eugene R.
Childers, Donald Gene
Couch, Leon Worthington, II
Cross, Jerome Lee
Director, Stephen William
Doty, Keith Lonnie
Dove, Derek B.
Durling, Allen Edgar
Elgred, Olle Ingemar
Fagen, William F.
Forsman, Marion Edwin
Gano, Ovid Raymond
George, Theordore Samuel
Harden, Richard Clayton
Hsiao, Mu-Yue
Johnson, Raymond Clarence
Jones, Lloyd Edgar, III
Kundel, Tewes
Kaiser, William Francis
Latour, Marinus Henry
Li, Sheng-San
Lindholm, Fred Arthur
Lipovski, Gerald John
Madigan, John Regan
Manders, Arnfinn Moe
Nevis, Arnold H.
Nickelson, William Richard David
O'Malley, John Richard
Paige, Arnold
Priem, Ervin Samuel
Ramey, Robert Ancel
Rosier, Nelson Eugene
Sah, Chih-Tang
Sashoff, Stephen Pencheff
Schoonmaker, L. E. (Emeritus)
Shaffer, Charles Vernon
Simons, Fred Oliver
Skellett, A. M.
Smallwood, Mark Harrison
Smith, Jack Reginald
Smith, Edward Frank
Sutherland, Alan Duryea
Tou, Julius T.
van der Ziel, Albert
Walker, Robert Lynn
Walter, William Austin
Watson, James Kenneth
Weil, J. (Emeritus)
Wheeler, Lawrence Arthur
Wing, Alexander Holbrook
Yii, Roland
Zetrouer, Wallace Feaster

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

Bevis, Herbert Anderson
Bolch, William Emmett

Brenzonik, Patrick Lee
Dunavant, Billy Glenn
Fox, Jackson Leland
Furman, Thomas deSaussure
Gibbs, Kenneth Charles
Heaney, James Patrick
Huber, Wayne Charles
Mauderli, Walter
McCaldin, Roy Oeland
Morgan, William Herman
Putnam, Hugh Dyer
Pyatt, Edwin Eugene
Sholtes, Robert Stephen
Singley, John Edward
Stewart, Robert Earl
Susag, Russell Harry

DEPARTMENT OF MECHANICAL ENGINEERING

Bourke, N. (Emeritus)
Farber, Erich Alexander
Flanigan, Frank McChesney
Freeman, Watson Louis
Gaither, Robert Barker
Gater, Roger Allen
Gilbert, Joel Sterling
Hsieh, Chung Kuo
Ingman, Hal Maury
Irey, Richard Kenneth
Mahig, Joseph
Morrison, Clayton Allison
Oliver, Calvin Cleet
Patterson, Elam Pusey
Pennington, Clark William
Piotrowski, George
Prescott, F. L. (Emeritus)
Reed, John Clifford
Roan, Vernon Parker
Samuel, John Alton
Schwartz, Frank Leroy
Smith, James Hunn
Smith, W. O. (Emeritus)
Tesar, Delbert
Vance, John Milton

To obtain further information, address all inquiries directly to:

Director
Center for Aquatic Sciences
University of Florida
Gainesville, Florida 32601

## UNIVERSITY OF HAWAII
### HONOLULU, HAWAII

The University of Hawaii is one of the first schools in the United States to offer a degree in ocean engineering. This is defined as the application of engineering principles and techniques to the ocean environment. The current program is an interdisciplinary one at both the Master of Science and Doctor of Philosophy levels, and involves the departments of oceanography as well as civil, electrical, and mechanical engineering. The department also offers undergraduate courses in ocean engineering disciplines.

The graduate program in ocean engineering is intended to channel the previous engineering experience of the student to ocean-related work. This work includes coastal and harbor engineering, marine structures, naval architecture, hydrodynamics and ocean acoustics. The department currently offers a master's and a doctoral program in ocean engineering.

An intended candidate for the master's program is expected to have a bachelor's degree in any of the classical engineering disciplines. Candidates with degrees other than in engineering will be considered for admission, but they may be required to make up deficiencies. Official scores in the GRE Aptitude tests must be submitted prior to admission.

The M.S. degree in ocean engineering can be earned by completing the requirements under one of two plans. Plan A (thesis program) requires a minimum of 30 credit hours, including 22 credit hours of course work and eight of thesis research. Six credit hours may be taken outside the College of Engineering and the department of oceanography. Two graduate seminars in engineering or oceanography are required. A minimum of 18 credits must be in courses numbered 600-799. Plan B (nonthesis) requires a minimum of 30 credit hours of course work. At least six credits must be outside the undergraduate field of specialization. Two graduate seminars in engineering or oceanography are required. A minimum of 18 credits must be in courses numbered 600-799.

Students will or must make a choice of plan before 14 credits of graduate work applicable to the degree have been completed. A foreign language is not required. All students will be required to take a general examination before they are advanced to candidacy. This examination is intended to reveal the quality of the student's preparation and his ability to pursue work at the master's level. The student may be required to make up any deficiencies before advancement to candidacy.

In addition to the credit hour requirements, students will be required to take a final oral examination. For Plan A this examination covers the thesis and related subjects. The examination is conducted by the thesis committee and is open to the graduate faculty. For Plan B the examination covers the presentation of a seminar, which must be submitted to the committee as a written paper. The student will be questioned on the paper and related subjects.

The general and final examination can only be repeated once. Students failing any of these examinations a second time will be dropped from the program.

Students seeking admission to the doctorate should have an M.S. degree in engineering. If they have an M.S. degree in another field, they should or may apply for a special examination to determine their qualifications. Exceptionally well-qualified students who meet the requirements for the M.S. program may be admitted to the Ph. D. program directly. Applicants must submit the official GRE Aptitude score prior to admission.

Students pursuing the doctoral program will be required to take an oral qualifying examination, an oral and written comprehensive examination and a final oral examination in defense of their dissertation. One foreign language is required. The following courses are recommended for all students in ocean engineering: OE 411, OE 601, OE 603, OE 609, OE 696, Ocn 620. Six credits of approved courses may be selected from physics, mathematics, chemistry, or geosciences.

The following courses are offered in conjunction with the above programs:

## OCEAN ENGINEERING

| | | |
|---|---|---|
| 411 | Naval Hydrostatics | 3 |
| 412 | Naval Hydrodynamics I | 3 |
| 601 | Ocean Engineering Laboratory | 3 |
| 603 | Ocean Engineering Environment | 3 |
| 609 | Principles of Ocean Engineering | 3 |
| 610 | Viscous Fluid Dynamics | 3 |
| 611 | Naval Hydrodynamics II | 3 |
| 612 | Naval Hydrodynamics III | 3 |
| 614 | Ocean Hydrodynamics Laboratory | 2 |
| 621 | Introducation to Ocean Acoustics | 3 |
| 622 | Sonar Systems Engineering | 3 |
| 623 | Electro-acoustics | 3 |
| 631 | Design of Ocean Structures I | 3 |
| 632 | Design of Ocean Structures II | 3 |
| 661 | Coastal and Harbor Engineering | 3 |
| 662 | Coastal and Harbor Engineering | 3 |
| 663 | Design of Coastal Structures | 3 |
| 664 | Sediment Transport, Littoral Drift and Dredging Technology | 3 |
| 671 | Submarine Vehicle Naval Architecture | 3 |
| 691 | Special Topics in Ocean Engineering | arr. |
| 696 | Topics in Ocean Engineering | 2 |
| 697 | Seminar in Ocean Engineering | 1 |
| 698 | Seminar in Ocean Engineering | 1 |
| 707 | Statistical Dynamics of Ocean Systems I | 3 |
| 708 | Statistical Dynamics of Ocean Systems II | 3 |
| Ocn 620 | Physical Oceanography | 3 |

The University also offers graduate programs in Marine Science which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Adams, W. M., Ph.D., geophysics, geophysical engineering
Allmendinger, E. E., M.S., naval architecture
Bretschneider, C. L., Ph.D., Chairman, civil engineering, physical oceanography
Burbank, N. C., Sc.D., environmental engineering

To obtain further information, address all inquiries directly to:

Dr. John P. Craven
Dean, Marine Programs
University of Hawaii
Honolulu, Hawaii, 96822

## UNIVERSITY OF HOUSTON
### HOUSTON, TEXAS

Marine sciences are taught in the Cullen College of Engineering and in the College of Arts and Sciences. The University has a SDS Sigma 7 digital computing system available to qualified students, and the Cullen College of Engineering is currently adding a large scale modern hybrid computing facility for engineering research. In addition, the Engineering School has acquired two large analog computing facilities from the General Electric Company and a large scale digital computer ideal for instructional purposes from NASA. Sea going vessels are available to all students through ocean related programs of Geology and Biology Departments. Students also have access to offshore drilling platforms of the oil industry. The University and Texas A&M University are developing a cooperative program in ocean engineering which will make available a large oceanographic research vessel and additional shore-based facilities. The University is a member of the Gulf Universities Research Corporation, which is described in the Consortia section of this publication.

The Cullen College of Engineering has recently moved into a new engineering building with adequate classroom and laboratory facilities for instruction in oceanography, ocean engineering, and related fields. In the College of Arts and Sciences, the Department of Geology has about 26,500 square feet of space, Biophysics about 9,000 square feet, and Biology about 50,000 square feet. Modern research facilities, including wet labs and cold storage, are available on the main campus, and supplementary facilities including a marine laboratory and fish tank have been developed at the University's Coastal Environment Field Station, comprising 1,600 acres in the Galveston Bay Area south of Houston.

The Master of Science and Doctor of Philosophy Degrees with Ocean Engineering options are granted in Chemical Engineering, Civil Engineering, Electrical Engineering, and Mechanical Engineering. In addition, Master of Science (Undifferentiated) and Doctor of Philosophy (Undifferentiated) Degrees may be granted in interdisciplinary ocean engineering programs and in the College of Arts and Sciences.

The requirements for these degrees are as follows:

1. Master of Science. Twenty-four or more semester hours of academic work are required in addition to a thesis which counts for a minimum of six semester hours. At least 12 semester hours, excluding the thesis, must be completed within the major field, and, at the discretion of the department chairman, 18 semester hours may be required in the major field. No student may register for credit for more than 13 semester hours, exclusive of thesis and seminar in any one semester.

The student must satisfactorily defend his thesis, prior to its acceptance, before a committee appointed by the department chairman and approved by the Dean of the Cullen College of Engineering.

Before a student has completed 12 semester hours of graduate study, he may be required to take a written examination covering the fundamentals of engineering and mathematics. If he fails to perform satisfactorily in any given area, he will be required to take additional work to remove the indicated deficiency.

2. Doctor of Philosophy.

a. A minimum of 52 semester hours of approved graduate study beyond the master's degree, to include the following:

(1) Major courses, 7-10 semester hours

(2) Electives in related fields, 12-15 semester hours

(3) Research and Dissertation, 20 semester hours

b. A minimum of two semesters and two summer sessions of residence in full-time graduate study.

c. Successful completion of written qualifying examination.

d. Technical reading examination or approved academic training (six semester hours) in a modern foreign language (ex-

cluding a student's native language) pertinent to the individual research program or taking a minimum of six hours in an approved field other than his major or minor area.

e. Original research work, leading to a publishable contribution to engineering science, must be carried out under the direction of a faculty member and, upon completion, the candidate must defend the written dissertation in a final oral examination.

f. Admission to candidacy: After completing the qualifying examination, the foreign language requirement, and 30 semester hours of the program, and with the approval of the department, the student will be admitted to candidacy.

The Cullen College of Engineering has undergraduate programs in chemical, civil, electrical, industrial, and mechanical engineering. In addition, these departments have graduate course offerings in many areas of special interest to ocean engineering. Some of the most significant of these courses in the Chemical Engineering Department are: (All courses numbered 600 and above are exclusively for graduate students)

| | |
|---|---|
| ChE 530 | Corrosion |
| ChE 664 | Flows Through Porous Media |
| ChE 731 | Advanced Fluid Mechanics I |
| ChE 733 | Gas Dynamics II |
| ChE 735 | Advanced Fluid Mechanics II |
| ChE 736 | Advanced Fluid Mechanics III |

The Department of Electrical Engineering also offers supporting course offerings for ocean engineering. Some of the most significant of the electrical engineering courses which are applicable to ocean engineering development include:

| | |
|---|---|
| EE 575A | Control Engineering |
| EE 576A | Communication Theory |
| EE 617 | Propagation and Microwave Laboratory |
| EE 618 | Propagation and Microwave Laboratory |
| EE 630 | Foundations of Analysis |
| EE 631 | Information Theory |
| EE 633 | Control System Design |
| EE 637B | Advanced Electromagnetic Waves |
| EE 663 | Environmental Biotechnology |
| EE 664 | Systems Biotechnology |
| EE 669 | Ocean Engineering Instrumentation |
| EE 690 | Engineering Analysis I |
| EE 691 | Engineering Analysis II |
| EE 737 | Statistical Wave Propagation |
| EE 739 | Advanced Topics in Electromagnetic Theory |

These courses are in addition to programs in electronics, control engineering, information theory, and hybrid computer applications.

The Mechanical Engineering Department at the University of Houston offers courses in fluid mechanics, hydrodynamics, and vibration analysis - all of which are pertinent to an ocean engineering program. Some of the most significant courses currently being offered in Mechanical Engineering include:

| | |
|---|---|
| ME 565 | Vibration - Acoustical Transducers |
| ME 571 | Vibration Analysis |
| ME 638 | Aerothermodynamics |
| ME 660 | Introduction to Advanced Dynamics |
| ME 661 | Analytical Methods in Vibrations |
| ME 662 | Advanced Dynamics |
| ME 665 | Stress Waves in Continuous Media |
| ME 666 | Mechanical Radiation |
| ME 690 | Engineering Analysis I |
| ME 691 | Engineering Analysis II |
| ME 731 | Advanced Fluid Mechanics I - Laminar Flow |
| ME 732 | Hydrodynamics I |
| ME 733 | Gas Dynamics II |
| ME 734 | Hydrodynamics II |
| ME 735 | Advanced Fluid Mechanics II - Turbulent Flow |
| ME 736 | Advanced Fluid Mechanics III - Boundary Layer Flow |
| ME 739 | Hydrodynamics of Waves |
| ME 760 | Nonlinear Analysis |

The Mechanical Engineering Department has a special emphasis on underwater acoustics, including underwater horn design and propagation characteristics.

Although Ocean engineering is taught as an interdisciplinary program at the University of Houston, the primary responsibility for curricula development rests with the Department of Civil Engineering. The ocean engineering effort is aided by programs in environmental engineering, structures, and soil mechanics. Principal courses which pertain to ocean engineering in the Civil Engineering Department include:

| | |
|---|---|
| CE 533 | Evaluation of Water Quality in Natural Waters |
| CE 573 | Introduction to Ocean Engineering |
| CE 582 | Air Monitoring and Measurements |
| CE 594 | Water Monitoring and Measurements |
| CE 630 | Hydrodynamics I |
| CE 631 | Hydraulics of Open Channel Flow |
| CE 639 | Soil Dynamics |
| CE 666 | Oceanographic Aspects of Coastal Engineering |
| CE 667 | Waterways, Ports, and Harbors |
| CE 668 | Environmental Factors in Ocean Engineering |
| CE 669 | Ocean Engineering Instrumentation |
| CE 681 | Microclimatology |
| CE 731 | Hydrodynamics II |
| CE 734 | Hydraulic Transients |
| CE 735 | Hydrodynamics of Waves |
| CE 761 | Interaction of Soils and Structures |
| CE 763 | Design of Offshore Structures I |
| CE 764 | Design of Offshore Structures II |

The University also offers graduate programs in marine science and ocean law which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

CULLEN COLLEGE OF ENGINEERING

Blumberg, Randolph, Ph.D., Associate Professor of Ocean Engineering
Castellanos, Leo John, M.E., Professor of Mechanical Engineering
Dalton, Charles, Ph.D., Associate Professor of Mechanical Engineering
Dukler, A. E., Ph.D., Professor of Chemical Engineering
Finch, Robert D., Ph.D., Associate Professor of Mechanical Engineering
Ghazzaly, Osman I., Ph.D., Assistant Professor of Civil Engineering
Graff, William J., Ph.D., Professor of Civil Engineering
Hayre, Harbhajan S., D.Sc., Professor of Electrical Engineering
Hwang, Neddy H. C., Ph.D., Associate Professor of Civil Engineering

Muster, Douglas F., Ph.D., Professor of Mechanical Engineering
Myrick, H. Nugent, Sc.D., Associate Professor of Civil Engineering
Overton, Harold L., M.S., Associate Professor of Petroleum Engineering
Rogers, Jerry R., Ph.D., Associate Professor of Civil Engineering
Schneider, William P., S.M., Professor of Electrical Engineering
White, Ardis H., Ph.D., Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

Dr. Ronald F. Bunn, Dean
The Graduate School
University of Houston
Houston, Texas 77004

## THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK
FORT SCHUYLER, BRONX, NEW YORK

The Engineering Department's physical facilities ashore are housed in the Engineering Wing (Tode Hall) of the new Science and Engineering Building. Tode Hall houses modern laboratories, classrooms, faculty offices and conference facilities.

The eight laboratories ashore are:

1. The Analog Computer Laboratory is equipped with fully expanded Electronic Associates Incorporated computers, models: - one EAI580 and three TR20.
2. The Electrical and Electronic Engineering Laboratory.
3. The Transport Process Laboratory is a thermal, heat transfer, and fluid mechanics facility.
4. The Marine Engineering Laboratory has an instrumented turbine power plant with its own 200 psi, 10,000 pound per hour package steam generator. In addition, it has test equipment and instrumentation associated with diesels, gasoline engines, gas turbines, fuel cells, an air compressor and an air conditioner and refrigeration test facility.
5. The Systems and Controls Laboratory has an Autodynamics, Inc. model 500 control systems trainer as well as four test stations each with air, gas, water, steam, and electrical; 60 and 400 cycle A.C. and D.C. systems available.
6. The Manufacture Processes Laboratory has lathes, milling machines, shapers, drill presses, welding booth facilities, metalizing and heat treating equipment.
7. The Strength of Materials Laboratory has extensive testing equipment including a 200,000 pound universal testing machine, three 60,000 pound universal testing machines, two 10,000 pound torsion machines, a Warner-Swasey vibration fatigue machine, and assorted accesories.
8. The Design and Graphics Laboratory has two sizes of drafting tables - one for normal design and/or drafting problems, and the second for large naval architectural studies.

The afloat engineering laboratory is in the engineering spaces of the 8500 HP converted C3 college training vessel that is berthed during the academic year alongside the college's 600-foot pier. The ship's propulsion power plant is extensively instrumented with equipment including a shaft torsionmeter, laboratory type pressure and temperature sensing devices, and 14 flowmeters that measure steam, water, gases, fuel oil and air. The instrumentation system is integrated so that basic design parameters, such as pounds fuel per SHP hr. is in continous readout. The ship can be effectively dock and sea trialed.

The College offers three Bachelor of Engineering curricula at its main campus: Marine Engineering, Naval Architecture, and Electrical Engineering. Each curriculum is registered for Professional Engineering Licensure by New York's Department of Education Division of Professional Licensure.

The Engineering students because of their course of studies may:

1. take Parts I and II of the New York State Professional Engineers Examination while in their senior year at the college.
2. take the U.S. Coast Guard's Third Engineer's operating engineer's license examinations for unlimited horsepower steam and motor vessels at the end of their junior year.
3. receive an Ensign's commission in the U.S. Naval Reserve.

All three curricula, Marine Engineering, Naval Architecture, and Electrical Engineering, follow a common core of studies for the first two years. The studies include courses in mathematics (4 terms), physics (3 terms), chemistry (2 terms), humanities (4 terms), statics (1 term), dynamics & kinematics (1 term), and transport processes (1 term). For the first two summers, engineers have two six week training sea terms to Europe on the College's training vessel and ashore classes in operational and naval science subjects.

In the junior and senior years the students specialize in one of the above concentrations or majors. All have four more terms of humanities or social studies courses and a three month summer sea term. The students visit at least four countries in Europe that summer.

The following junior-senior courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| E341 | Solid Mechanics III | 3 |
| E342 | Transport Processes II | 4 |
| E343 | Engineering Analysis I | 3 |
| E381 | EE I and Lab | 4 |
| E351 | Solid Mechanics IV | 3 |
| E352 | Transport Processes III | 3 |
| E353 | Engineering Analysis II | 3 |
| E391 | EE II and Lab | 4 |
| E510 | Marine Propulsion Plants | 3 |
| E511 | Summer Sea Term (3 months) | 8 |
| E441 | Design I | 4 |
| E442 | Engineering Economics and Value | 3 |
| E443 | Analysis III | 3 |
| E361 | Naval Architecture | 3 |
| | Naval Science 402 | 3 |
| E451 | Design II | 4 |
| E452 | Controls | 3 |
| E453 | Nuclear & Modern Concepts | 3 |
| | Naval Science 401 | 3 |
| E471 | Ship Design II | 4 |
| E472 | Propeller Design | 2 |
| E454 | Vibrations | 4 |
| E363 | Ship Form & Stability | 4 |
| E362 | N.A. Graphics | 2 |
| E371 | Preliminary Design & Ship Economics | 3 |
| E373 | Ship Form & Stability II | 3 |
| E461 | Ship Design I | 5 |
| E462 | Ship Resistance | 3 |
| E463 | Ship Structure | 3 |

| | | |
|---|---|---|
| E383 | Network Analysis I | 4 |
| E384 | Electromagnetic Fields I | 3 |
| E385 | Energy Conversions | 3 |
| E393 | Network Analysis II | 3 |
| E394 | Electromagnetic Fields II | 3 |
| E396 | Electronics I | 4 |
| E481 | Random Processes | 3 |
| E483 | Network Analysis III | 3 |
| E486 | Electronics II | 4 |
| E491 | Communications Theory | 4 |
| E495 | Electromagnetic Systems | 4 |

The College also offers undergraduate programs in marine science and undergraduate and graduate training for maritime officers which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Chu, Fen-Dow, M.NA & M.E., Assistant Professor
Femenia, Jose, M.M.E., Assistant Professor
Foody, John J., M.M.E., J.D., P.E., Professor and Chairman of Engineering ashore and afloat
Gleicher, Norman J., M.M.E., E.I.T., Assistant Professor
Kramer, Aaron R., M.M.E., P.E., Associate Professor
Mathieson, John L., M.M.E., Assistant Professor
McNeill, Joseph G., Ed.D., Professor
Pergament, Stuart P., Ph.D., Assistant Professor
Pfleging, Edward F., B.S., C.E., Professor
Thornton, James K., M.S.E.E., P.E., Assistant Professor
Wennagel, Norman G., M.M.E., P.E., Professor
Zubaly, Robert B., M.S.M.E., E.I.T., Professor

STAFF

Di Natale, Pasquale, Machinist
Fiandaca, Alphonse, Technical Specialist
Hoetzl, Charles, B. of E.(M), Technical Specialist-Watch Officer
Rone, Edward C., Technical Specialist
Rowen, Alan L., B. of E.(M), Technical Specialist-Watch Officer
York, William A., B. of E.(M), Technical Specialist-Watch Officer

To obtain further information, address all inquiries directly to:

Dr. John J. Foody
Chairman of Engineering
State University of New York
Maritime College
Bronx, New York 10465

## UNIVERSITY OF MARYLAND
### COLLEGE PARK, MARYLAND

The Mechanical Engineering Laboratories contain apparatus and instrumentation for conducting research in fluid dynamics and transfer processes on marine-related problems. A flume, tanks, pumps, and auxiliary equipment have been used in recent projects on deep water heat transfer, jellyfish barries, vortex-induced vibration, and heat dissipation from power plant effluent. Wind tunnel and airflow facilicies are also available. The Chesapeake Biological Laboratory at Solomons, Maryland (a field research facility) is part of the University of Maryland and cooperates with departments on problems of mutual interest. Government and private laboratories in the Annapolis, Baltimore, Washington area have provided support and facilities to assist in research of mutual interest.

The following degrees are offered:

1. Ph.D. in Mechanical Engineering. The Ph.D. in Mechanical Engineering emphasizing ocean engineering or marine sciences is administered by the Fluid Mechanics Group of the M.E. Department. Although specific programs are tailored to fit individual needs and backgrounds, the general requirements are a minimum of 48 semester hours of courses plus 12 hours of dissertation research. The 48 semester hours of courses are distributed as follows: 27 semester hours in fluid mechanics (which may include courses in aerodynamics, meteorology, and ocean engineering), 9 hours in mathematics, and 12 hours in two other areas (either within the four other M.E. Groups or outside of the Department). Procedures for written comprehensive examinations and foreign language requirements are undergoing revision.

2. M.S. in Mechanical Engineering. The M.S. emphasizing ocean engineering or marine sciences is also administered by the Fluid Mechanics Group of the Mechanical Engineering Department. A thesis or non-thesis option is available. The course of study includes 12 hours in fluid mechanics (or appropriate equivalent), six hours of mathematics, six hours in another area of Mechanical Engineering (or outside of the Department) plus either six hours of thesis or six hours of additional courses in the general area of fluid mechanics, for a total of 30 semester hours.

The following courses are offered in conjunction with the above programs*:

GRADUATE

AGRICULTURAL ENGINEERING DEPARTMENT

| | | |
|---|---|---|
| AGEN 185 | Aquacultural Engineering | 3 |

DEPARTMENT OF CHEMISTRY

| | | |
|---|---|---|
| CHEM 106 | Oceanography | 3 |

METEOROLOGY

| | | |
|---|---|---|
| METO 120 | Physical and Dynamical Oceanography | 3 |
| METO 122 | Ocean Waves, Tides and Turbulence | 3 |
| METO 220 | Physical and Dynamical Oceanography | 3 |

DEPARTMENT OF MECHANICAL ENGINEERING

| | | |
|---|---|---|
| ENME 180 | Mechanical Engineering Analysis for the Oceanic Environment | 3 |
| ENME 181 | Mechanical Engineering Systems for Underwater Operations | 3 |

*Courses numbered 1XX are available for either graduate or undergraduate credit.

The University also offers graduate programs in marine science which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

AGRICULTURAL ENGINEERING DEPARTMENT

Wheaton, Frederick W., Ph.D., Research Associate

DEPARTMENT OF CHEMISTRY

Sommer, Sheidon E., Ph.D., Assistant Professor

METEOROLOGY

Faller, Allan J., Ph.D., Research Professor, Instructor of Fluid Dynamics and Applied Mathematics

DEPARTMENT OF MECHANICAL ENGINEERING

Marks, Colin H., Ph.D., Assoicate Professor
Sayre, Clifford L., Jr., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Head, Department of Mechanical Engineering
College of Engineering
University of Maryland
College Park, Maryland 20742

## MASSACHUSETTS INSTITUTE OF TECHNOLOGY
### CAMBRIDGE, MASSACHUSETTS

Over the past decade the Massachusetts Institute of Technology has developed a wide range of facilities for applied research related to the utilization of the oceans and the ocean resources. In addition to the facilities in basic and engineering research in the various departments of the Institute and the facilities of the Draper Laboratory (formerly Instrumentation Laboratory) and the Information Processing Services Center as well as those of the Woods Hole Oceanographic Institution (available to MIT through the joint MIT/WHOI Program), the following special marine-oriented facilities are available: variable pressure water tunnel, ship model towing tank, acoustics and vibration laboratory, MIT ship structures laboratory, research vessel SHROCK, pressure testing facility, a stroboscopic light laboratory and the newly remodeled Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics. This Laboratory contains over 30,000 square feet devoted to teaching and research and includes such facilities as a 100-foot wave channel, various channels for sediment studies, a coastal model basin, special flumes for variable density experiments, a special purpose digital computer for experimental control and data reduction, a special purpose analog computer for the analysis of random signals, plus instrumentation for the laboratory and field measurement of turbulence, wave profile and forces, entrained sediments, salinity, heat, dissolved oxygen, B.O.D., etc. Large scale digital computer facilities are available through the Engineering Departments, the Civil Engineering Systems Laboratory, and the M.I.T. Computation Center.

The Department of Civil Engineering offers marine-related graduate degree programs in Civil Engineering with major fields of study in Hydrodynamics and in Ocean Engineering. The focus of these programs is on coastal problems of the marine environment and on constructed marine facilities. A vital part of these educational programs is the involvement of each student in a research environment in partnership with the faculty; facilities for this research are available through the Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics.

Preparation for these programs of graduate study usually includes an undergraduate degree in Civil, Mechanical, Marine or Electrical Engineering or Oceanography; but, recognizing the possible need for some additional work, students with a background in physics, mathematics, chemistry, and biology may also be accepted. The degrees offered, and their requirements are as follows:

1. M.S. in Civil Engineering. This requires completion of an approved program of at least 66 subject units, of which 42 units must be in "A" subjects, and the completion of an acceptable thesis.
2. M.S.. This "unspecified" degree is awarded in cases in which at least 34 units of "A" subjects plus the thesis are not from within the Department of Civil Engineering. This provides one mechanism for pursuing interdepartmental fields of interest.
3. Civil Engineer. The "professional" degree, Civil Engineer, is awarded for completion of a program at a more advanced level and over a broader range than that for the Master's degree but with less emphasis on creative research than that characterizing a doctoral program. The program content is worked out by the student in consultation with his faculty advisor but must contain at least 162 subject units plus an acceptable thesis.
4. Sc.D. or Ph.D. in Civil Engineering. The basic requirements for the doctorate are: a) completion of a program of advanced study, including a general examination consisting of a written and an oral portion; and b) completion and oral defense of a thesis based on original research.

The total doctoral program must include at least 150 units of graduate subject units up to half of which may be specified by the graduate committee in charge of the candidate's major area of specialization. It is for this core material that the candidate is responsible on the general examination. Doctoral candidates are no longer required to demonstrate a proficiency in foreign languages.

The Department of Naval Architecture and Marine Engineering concentrates on "Engineering for the Ocean Environment". It emphasizes the scientific background and those engineering sciences necessary to applications in the marine field, as well as engineering fundamentals and their application to a wide spectrum of engineering for modern ocean sciences, ocean exploration, ocean transportation, ship and naval engineering, and the utilization of ocean resources. A flexible curriculum, a depart-

mental faculty with wide and continuing research and industrial experience, and close faculty-student contact all contribute to a sound and effective education.

The following degrees are offered in the Department of Naval Architecture and Marine Engineering:

5. B.S. in Naval Architecture and Marine Engineering. All undergraduate students are required to take 68 units in the academic area of Humanities and Social Science. In addition, 12 units of Chemistry subject matter, 24 units of Physics and 24 units of Calculus are required. Each student must fulfill the requirement of satisfactorily completing 12 units of credit in a laboratory course. All of the foregoing requirements involve subjects outside the Department of Naval Architecture and Marine Engineering. The Departmental requirements include the following mandatory subjects:

| | |
|---|---|
| 2.01 | Mechanics of Solids |
| 2.02 | Introduction to System Dynamics |
| 2.201 | Fluid Mechanics |
| 2.403 | Thermodynamics |
| 3.141 | Science of Materials |
| 13.00 | Introduction to Marine Hydrodynamics |
| 13.20 | Energy Conversion Systems and Components |
| 13.30T | Ship Structural Analysis and Design |
| 13.40 | Introductory Ship Design |
| 18.034 | Differential Equations |
| 18.05 | Advanced Calculus for Engineers |
| | Thesis |

6. M.S. in Shipping and Shipbuilding Management
7. M.S. in Marine Engineering
8. M.S. in Naval Architecture
9. M.S. in Naval Engineering
10. M.S. in Ocean Engineering

A program of graduate study in the Department is almost entirely under the control of the student, with assistance in his planning by his Graduate Registration Officer. The program of studies for an advanced degree must be acceptable to the Departmental Committee on Graduate Students. Unless special approval is given by this Committee, candidates for any graduate degree are expected to include in their programs at least one term of advanced mathematics beyond the requirements of the Department's undergraduate curriculum. The program for an M.S. degree must include a minimum of 72 subject units plus a thesis acceptable to the Department. A minimum of 48 of the 72 units must be "A" subjects.

To be recommended for a Master's degree, a student must have, in addition to a clear record in a program of graduate study and research as defined above, a scholastic standing of a distinctly high grade.

11. Nav.E. - Naval Engineer
12. Nav. A. - Naval Architect
13. Mar. Mech. E. - Marine Mechanical Engineer
14. Ocean E. - Ocean Engineer

The objective of a program leading to an Engineer degree is a more advanced level and a broader range of competence in engineering and science than that required for the Master's degree, but with less emphasis on creative research than that characterizing a doctoral program. In general terms, the Master's degree requires a minimum of one academic year and the Engineer degree two academic years beyond a baccalaureate in the same field.

The requirements for an Engineer degree are the satisfactory completion of a program of advanced study and research approved by the Department. The minimum program consists of at least 162 subject units and the completion of an acceptable thesis. A department may accept a Master's thesis of superior quality for the Engineer degree.

A program for an Engineer degree ordinarily includes two subjects in the area of economics, industrial management, or political science, and at least 12 units of comprehensive design, such as Design of a Waterborne Vehicle (13.42), or the equivalent. A signle thesis will generally be acceptable for both the Master of Science and Engineer degrees, provided it is appropriate to the specifications of both degrees.

15. Sc.D. - Doctor of Science
16. Ph.D. - Doctor of Philosophy

The basic requirements for a doctorate are: a) completion of a program of advanced study, including a general examination, and b) completion and oral defense of a thesis on original research.

The program of advanced study and research may be selected in any field approved by the Department. The thesis is in this same field. The program often comprises subject areas reaching into several departments. If the field requires substantial participation by two or more departments, an interdepartmental faculty committee may be appointed by the Dean of the Graduate School to advise with a Graduate Registration Officer in the administration of the student's program.

Each doctoral candidate will have a general examination in his field at such time and in such manner as his departmental or interdepartmental committee approves. This examination consists of both oral and written parts.

Candidates for a doctorate are no longer required to demonstrate a proficience in foreign languages.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF CIVIL ENGINEERING

| | | |
|---|---|---|
| 1.071 | Analysis of Uncertainty | 9 |
| 1.131 | Applications of Multivariate Statistical Analysis (A) | 9 |
| 1.142 | Numerical Methods of Engineering Analysis (A) | 9 |
| 1.143 | Mathematical Optimization Techniques I (A) | 9 |
| 1.144 | Mathematical Optimization Techniques II (A) | 9 |
| 1.146 | Elements of Systems Analysis (A) | 9 |
| 1.147 | Engineering Systems Analysis (A) | 9 |
| 1.151 | Computer Approaches to Engineering Problems | 9 |
| 1.154 | Simulation Methods (A) | 9 |
| 1.561 | Advanced Structural Mechanics (A) | 9 |
| 1.582 | Structural Reliability (A) | 6 |
| 1.584 | Analysis and Design of Shell Structures (A) | 9 |
| 1.586 | Structural Dynamics (A) | 9 |
| 1.631 | Advanced Hydromechanics I (A) | 9 |
| 1.632 | Advanced Hydromechanics II (A) | 9 |
| 1.681 | Experimental Hydromechanics (A) | 6 |
| 1.683 | Experimental Hydromechanics (A) | 6 |
| 1.69 | Waves and Coastal Processes (A) | 9 |

| | | |
|---|---|---|
| 1.70 | Mechanics of Sediment Transport (A) | 6 |
| 1.77 | Water Quality Control (A) | 8 |

DEPARTMENT OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

| | | |
|---|---|---|
| 13.00 | Introduction to Marine Hydrodynamics | 12 |
| 13.001 | Introduction to Marine Applied Mechanics | 12 |
| 13.002 | Marine Applied Mechanics | 12 |
| 13.01 | Applied Hydrostatics | 10 |
| 13.02 | Marine Hydrodyanmics | 12 |
| 13.03 | Advanced Hydromechanics of Ship Design (A) | 9 |
| 13.04 | Two-Dimensional Hydrofoil Theory (A) | 12 |
| 13.05 | Three-Deminsional Hydrofoil Theory (A) | 12 |
| 13.06 | Propulsion Hydrodynamics | 6 |
| 13.07 | Free Surface Hydrodynamics (A) | 9 |
| 13.08 | Stability and Motion Control of Ocean Vehicles (A) | 9 |
| 13.10 | Introduction to Structural Mechanics | 9 |
| 13.11 | Theory of Plates and Shells (A) | 9 |
| 13.12 | Marine Structures (A) | 9 |
| 13.13 | Plastic Analysis of Structures | 9 |
| 13.151J | Welding Engineering (A) | 9 |
| 13.161J | Properties of Metals | 11 |
| 13.20 | Energy Conversion Systems and Components | 12 |
| 13.21 | Ship Propulsion (A) | 6 |
| 13.22 | Naval Ship Propulsion (A) | 12 |
| 13.30T | Ship Structural Analysis and Design | 9 |
| 13.31 | Ship Structural Design | 4 |
| 13.32 | Ocean Engineering Structures | 9 |
| 13.34 | Ship Structural Design I (A) | 5 |
| 13.36 | Ocean Engineering Structural Design | 5 |
| 13.39 | Analysis of Techniques for Fabricating Structures (A) | 6 |
| 13.40 | Introductory Ship Design | 9 |
| 13.41 | Principles of Ship Design (A) | 11 |
| 13.42 | Design of a Waterborne Vehicle (A) | arr. |
| 13.43 | Naval Ship-System Design I (A) | 9 |
| 13.44 | Naval Ship-System Design II (A) | 5 |
| 13.45T | Principles of Naval Ship Design (A) | 6 |
| 13.46T | Conceptual Design of Naval Ships (A) | arr. |
| 13.47J | Special Studies in Systems Engineering (A) | 12 |
| 13.50 | Computer Application to Marine Problems | 8 |
| 13.51 | Computer Systems for Naval Architecture and Marine Engineering (A) | 6 |
| 13.60 | Application of Operational Methods | 12 |
| 13.61 | Decision Processes in Ship Operation and Construction (A) | 9 |
| 13.62 | Shipping Economics (A) | 9 |
| 13.64 | Hydrospace Vehicles | 6 |
| 13.65 | Ship Production Analysis (A) | 6 |
| 13.66 | Economics of Marine Systems | 9 |
| 13.67 | Marine Decision-Making Under Uncertainty | 9 |
| 13.68 | Systems Reliability and Maintainability | 9 |
| 13.700-13.709 | Special Problems in Naval Architecture and Marine Engineering I | arr. |
| 13.710-13.719 | Special Problems in Naval Architecture and Marine Engineering II | arr. |
| 13.72 | Methods of Harmonic and Statistical Analysis (A) | 9 |
| 13.73 | A Survey of Ocean Engineering | 2 |
| 13.80 | Mechanical Vibrations (A) | 9 |
| 13.82 | Acoustics and Shock Response of Marine Structures (A) | 9 |
| 13.83 | Hydroacoustics (A) | 9 |
| 13.84J | Flow Noise (A) | 12 |
| 13.85 | Fundamentals of Underwater Sound Applications | 9 |
| 13.920J | Public Policy and Use of the Seas | 9 |
| 13.990 | Oceanographic Systems I | 12 |
| 13.991 | Oceanographic Systems II | 12 |
| 13.992 | Oceanographic Systems Analysis I | 9 |
| 13.993 | Oceanographic Systems Analysis II | 9 |
| 13.994 | Buoy Engineering | 6 |
| 13.995 | Oceanographic Deep Submergence Engineering | 9 |

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

| | | |
|---|---|---|
| 3.36J | Welding Engineering (A) | 9 |
| 3.54 | Corrosion (A) | 8 |
| 3.701J | Properties of Metals | 11 |

DEPARTMENT OF MECHANICAL ENGINEERING

| | | |
|---|---|---|
| 2.032 | Advanced Mechanics (A) | 12 |
| 2.083 | Applied Elasticity (A) | 12 |
| 2.25 | Advanced Fluid Mechanics (A) | 12 |
| 2.271 | Compressible Fluid Mechanics (A) | 12 |
| 2.275 | Dynamic Fluid Machines (A) | 12 |
| 2.284 | Desalination and Water Purification (A) | 12 |
| 2.412 | Heat Engineering | 12 |
| 2.451 | Intermediate Thermodynamics (A) | 12 |
| 2.452T | Advanced Thermodynamics (A) | 12 |
| 2.54 | Heat Transfer | 6 |
| 2.55 | Advanced Heat Transfer (A) | 12 |
| 2.621 | Gas Turbines (A) | 12 |

The Institute also offers a graduate degree program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL ENGINEERING

Christian, John T., Ph.D., Associate Professor of Civil Engineering
Connor, Jerome J., Jr., Sc.D., Associate Professor of Civil Engineering
Cornell, C. Allin, Ph.D., Associate Professor of Civil Engineering
Cross, Ralph H., III, Ph.D., Assistant Professor of Civil Engineering
de Neufville, Richard L., Ph.D., Associate Professor of Civil Engineering
Gelhar, Lynn W., Ph.D., Associate Professor of Civil Engineering
Godfrey, Michael B., Sc.D., Assistant Professor of Civil Engineering
Harleman, Donald R. F., Sc.D., Professor of Civil Engineering
Ippen, Arthur T., Ph.D., Institute Professor
Marks, David H., Ph.D., Assistant Professor of Civil Engineering
Mei, Chiang C., Ph.D., Associate Professor of Civil Engineering
Perkins, Frank E., Sc.D., Associate Professor of Civil Engineering
Roesset, Jose M., Sc.D., Associate Professor of Civil Engineering

Sussman, Joseph M., Ph.D., Assistant Professor of Civil Engineering

DEPARTMENT OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

Abkowitz, Martin A., Ph.D., Professor of Naval Architecture
Carmichael, A. Douglas, Ph.D., Professor of Power Engineering
Cummings, Damon E., Ph.D., Assistant Professor of Naval Architecture
Devanney, John W., III, Ph.D., Assistant Professor of Naval Architecture
Dietz, Warren C., Sc.D., Professor of Marine Engineering
Evans, John H., B. Eng., Professor of Naval Architecture
Frankel, Ernst G., Mar. Mech. E., Professor of Marine Engineering
Frisch, Franz, A. P., Diplom Ingenieur, Lecturer of Marine Transportation
Jones, Norman, Ph.D., Assistant Professor of Naval Architecture
Junger, Miguel C., Sc.D., Senior Lecturer of Hydroacoustics
Keil, Alfred A H., Dr., Rer. Nat., Head of Department and Professor of Naval Architecture and Marine Engineering
Kerwin, Justin E., Ph.D., Professor of Naval Architecture
Leehey, Patrick, Ph.D., Professor of Naval Architecture
Mandel, Philip, B.S., Professor of Naval Architecture
Mansour, **Alaa,** Ph.D., Assistant Professor of Naval Architecture
Masubuchi, Koichi, D. Eng., Associate Professor of Naval Architecture
Milgram, Jerome H., Ph.D., Assistant Professor of Naval Architecture
Newman, John N., Sc.D., Associate Professor of Naval Architecture
Padelford, Norman J., Ph.D., Professor of Political Science
Pellini, William S., B.S., Senior Lecturer of Ocean Engineering Materials
Porter, William R., Ph.D., Professor of Naval Architecture
Powell, S. Curtis, Dott. Ing., Associate Professor of Marine Engineering
Romberg, Bernhard W., Ph.D., Lecturer of Computer Systems Applications

DEPARTMENT OF METALLURGY AND MATERIALS SCIENCE

Floe, Carl F., Sc.D., Professor of Metallurgy
Uhlig, Herbert H., Ph.D., Professor of Metallurgy

DEPARTMENT OF ELECTRICAL ENGINEERING

Edgerton, Harold E., Sc.D., Professor of Electrical Measurements, Emeritus

DEPARTMENT OF MECHANICAL ENGINEERING

Den Hartog, Jacob P., Ph.D., Professor of Mechanical Enginering, Emeritus
Hatsopoulos, George N., Sc.D., Senior Lecturer of Thermodynamics
Keenan, Joseph H., L.L.D., Professor of Mechanical Engineering, Emeritus
Lardner, Thomas J., Ph.D., Associate Professor of Mechanical Engineering
Probstein, Ronald F., Ph.D., Professor of Mechanical Engineering
Rohsenow, Warren M., D.Eng., Professor of Mechanical Engineering
Sonin, Ain A., Ph.D., Associate Professor of Mechanical Engineering
Stickney, Robert E., Ph.D., Associate Professor of Mechanical Engineering
Wilson, David G., Ph.D., Associate Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Ocean Engineering Information
Admissions Office, Room 3-108
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Professor Peter S. Eagleson, Head
Department of Civil Engineering
Room 1-290
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Professor Alfred A. H. Keil, Head
Department of Naval Architecture and Marine Engineering
Room 5-226
Cambridge, Massachusetts 02139

## UNIVERSITY OF MASSACHUSETTS
AMHERST, MASSACHUSETTS

The University offers marine sciences courses at the Amherst campus and individual research opportunities at the Gloucester Marine Station. The Ocean Engineering Program is a degree-granting unit of the Civil Engineering Section of the College of Engineering. The College of Engineering is housed in three buildings, one of which includes the University Computing Center with two CDC 3600 computers. Students on the Amherst campus also may participate in The Five College Community sharing the facilities of Amherst, Smith, Mt. Holyoke and Hampshire Colleges. In June 1970, the University acquired property for a marine station at Hodgkin's Cove in Gloucester on the north shore of Cape Ann. The first building is now being renovated as a research laboratory and additional teaching-research facilities are planned. Dockage for vessels up to 160 feet is now available at Hodgkin's Cove and at nearby Gloucester, and fishing vessels are available for charter for research and teaching. Assorted small craft are already available for inshore and estuarine studies.

The University offers the following degrees:

1. Master of Science in Ocean Engineering. The Ocean Engineering Program is administered as a degree-granting subdivision of the Civil Engineering Department, but provides for and preserves the interdisciplinary nature of ocean engineering. Programs leading to the Master of Science in Ocean Engineering are designed to promote an understanding of the ocean environment while developing greater competence in a field of engineering applicable to ocean-oriented technical problems. Students seeking this degree should have a baccalaureate degree in either engineering or science, with enough mathematics, physics, and chemistry to permit undertaking engineering graduate studies. The admittant should be proficient in: general chemistry and physics, calculus and elementary differ-

ential equations, engineering mechanics (fluid and solid), basic thermodynamics and heat transfer, and basic electrical circuits. Three core courses are required of the candidate: MS 525, OE 510 (CE 559) and a choice of OE 530 (CE 580), OE 550 (EE 587), OE 570 (CE 590), and OE 571 (CE 591). Each Candidate must complete two or more courses in a single specialty: acoustics; applied physical oceanography; energy storage and conversion; marine corrosion and materials engineering; marine propulsion; navigation, control, and information processing; ocean structures and marine foundations; ocean systems engineering and design; operations research for the ocean environment; and systems for aquacultural engineering. All candidates will complete at least a six-hour thesis. Nine hours will be elective courses approved by an advisor to form a cohesive program.

2. Doctor of Philosophy in Ocean Engineering. Applicants should meet the background requirements listed for the Master of Science program. A core curriculum of six courses that may already have been completed by the Master's degree is required: MS 525; OE 510 (CE 559); OE 530 (CE 580); OE 550 (EE 587); OE 570 (CE 590); and OE 571 (CE 591). The doctoral program in Ocean Engineering is designed to prepare individuals for high-level professional careers in academic, governmental, or industrial situations. No specific course requirements other than the core curriculum are prescribed, but it is the obligation of the candidate under the direction of his advisor to propose a unified program of study and research which will lead to the achievement of his academic and professional objectives. All candidates will obtain a first-hand familiarity with the sea; normally this will be obtained through participation in a prolonged oceanographic cruise.

The following courses are offered in conjunction with the above programs:

OCEAN ENGINEERING

| | | |
|---|---|---|
| OE 510 | Engineering Oceanography | 3 |
| OE 530 | Materials in the Ocean Environment | 3 |
| OE 550 | Marine Instrumentation | 3 |
| OE 570 | Engineering Design of Ocean System Payload Devices | 3 |
| OE 571 | Deep Ocean Systems Engineering and Design I | 4 |
| OE 591 | Aquacultural Engineering Systems | 3 |
| OE 701 | Underwater Acoustics | 3 |
| OE 711 | Fluid Mechanics of the Oceans | 3 |
| OE 712 | Ocean Wave Theory | 3 |
| OE 721 | Energy Storage and Conversion | 3 |
| OE 731 | Materials for Submarine Structures | 3 |
| OE 751 | Navigation | 3 |
| OE 752 | Dynamics and Control of Marine Vehicles | 3 |
| OE 761 | Submarine Soil Mechanics and Foundation Engineering | 3 |
| OE 763 | Structural Mechanics of Deep Submersible Vehicles | 3 |
| OE 764 | Coastal Structures | 3 |
| OE 765 | Analysis and Design of Offshore Structures | 3 |
| OE 772 | Deep Ocean Systems Engineering Design II | 4 |
| OE 773 | Public Policy and the Use of the Seas | 1 |
| OE 774 | Fundamentals of Naval Architecture | 4 |
| OE 775 | Ocean Engineering Field Laboratory I | 3 |
| OE 776 | Ocean Engineering Field Laboratory II | 3 |
| OE 777 | Coastal Engineering | 3 |
| OE 781 | Desing of Closely Confined Manned Operations Stations | 4 |

Other courses in all branches of engineering serve to support the Ocean Engineering Program. The Graduate Bulletin or Professor Heronemus, College of Engineering can be consulted for futher details.

The University also offers graduate programs in Marine Science and Fisheries Biology which are described in the appropriate sections of this publication

The instructional staff for the courses listed above consists of the following:

OCEAN ENGINEERING

GRADUATE FACULTY

Adams, Clayton R., M.S., Associate Professor of Civil Engineering
Bemben, Stanley M., Ph.D., Associate Professor of Civil Engineering
Carver, Charles E., Jr., Sc.D., Professor of Civil Engineering
Colonell, Joseph M., Ph.D., Associate Professor of Civil Engineering
Cromack, Duane E., D.Eng., Assistant Professor of Mechanical and Aero-Space Engineering
Dzialo, Frederick J., Ph.D., Associate Professor of Civil Engineering
Harris, Denton B., M.S.C.E., Assistant Professor of Civil Engineering
Heronemus, William E., M.S., Professor of Civil Engineering, Coordinator Ocean Engineering Program
Hill, Francis S., Jr., Ph.D., Assistant Professor of Electrical Engineering
Hutchinson, Charles E., Ph.D., Professor of Electrical Engineering
Lindsey, E. Ernest, D.Eng., Professor of Chemical Engineering
Mangarella, Peter A., Ph.D., Assistant Professor of Civil Engineering
Miller, Melton M., Jr., Ph.D., Associate Professor of Civil Engineering
Monopoli, Richard V., Ph.D., Professor of Electrical Engineering
Nash, William A., Ph.D., Professor of Civil Engineering
Osgood, Elmer C., D.Eng., Professor of Civil Engineering
Ritter, John E., Ph.D., Associate Professor of Mechanical and Aero-Space Engineering
Russell, G. Albert, Ph.D., Assistant Professor of Mechanical and Aero-Space Engineering
Sheckels, G. Dale, Ph.D., Professor of Electrical Engineering
Stockton, Fred D., Ph.D., Associate Professor of Civil Engineering
Thomas, Ian B., Ph.D., Associate Professor of Electrical Engineering
Zahradnik, John W., Ph.D., Professor of Biological Processing

To obtain further information, address all inquiries directly to:

William E. Heronemus
Program Coordinator for Ocean Engineering

Department of Civil Engineering
Marston Hall
University of Massachusetts
Amherst, Massachusetts 01002

## UNIVERSITY OF MIAMI
### CORAL GABLES, FLORIDA

Facilities include those of the School of Marine and Atmospheric Sciences and the School of Engineering. At SMAS, research vessels, extensive oceanographic laboratories, underwater acoustics laboratory, marine corrosion laboratories, ocean measurements facilities, classroom space, library, and digital computer are provided. At the School of Engineering, laboratories in Civil, Electrical, Industrial, and Mechanical Engineering are available to the Ocean Engineering students for course work and research.

The following degrees are offered:

1. M.S. in Ocean Engineering. This is an interdisciplinary program consisting of a minimum of 30 credits at the graduate level, of which six are for a thesis. At lease 12 credits must be at the 600 level (open to graduate students only) excluding thesis. PCO 501, OEN 502, and OEN 607 are required of all ocean engineering students and at least 12 credits must be in either ocean engineering or ocean related subjects. The areas of specialization center about underwater structures and coastal engineering, marine corrosion, ocean measurements, and underwater acoustics.
2. Ph.D. programs are available in the Civil and Mechanical Engineering Departments with specialization in Ocean Engineering.
3. Undergraduate programs in Ocean Engineering are available as options in the Civil, Electrical, Industrial, and Mechanical Engineering Departments. These are fully accredited programs in their respective traditional areas, but allow specialization in Ocean Engineering through choice of electives.

The Ocean Engineering, Physical and Chemical Oceanography, and the Electrical, Civil, Industrial, and Mechanical Engineering Departments offer courses related to Ocean Engineering.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| PHO 501 | Physical Oceanography | 3 |
| PHO 502 | Physical Oceanography Laboratory | 1 |
| OEN 502 | Introduction to Ocean Engineering | 1 |
| OEN 531 | Oceanographic Measurements | 3 |
| OEN 535 | Underwater Acoustics | 3 |
| OEN 539 | Random Signals and Noise I | 3 |
| OEN 551 | Special Problems | 1-3 |
| OEN 607 | Ocean Engineering Seminar | 1 |
| OEN 610 | Applied Ocean Hydrodynamics | 2 |
| OEN 611 | Engineering of Ocean Systems | 2 |
| OEN 632 | Advanced Ocean Measurements | 2 |
| OEN 634 | Underwater Acoustic Laboratory | 1 |
| OEN 635 | Advanced Underwater Acoustics | 3 |
| OEN 636 | Applied Underwater Acoustics | 3 |
| OEN 640 | Materials in the Marine Environment | 2 |
| OEN 641 | Marine Corrosion Laboratory | 1 |
| OEN 642 | Advanced Marine Corrosion | 2 |
| OEN 651 | Special Topics | 1-3 |
| OEN 690 | Advanced Topics in Ocean Engineering I | 1-3 |
| OEN 691 | Advanced Topics in Ocean Engineering II | 1-3 |
| CEN 509 | Coastal Engineering | 3 |
| CEN 617 | Underwater Structures | 3 |
| EEN 631 | Random Signals and Noise II | 3 |
| RES 600 | Thesis | 6 |

Many related courses are available in the School of Engineering and in the School of Marine and Atmospheric Sciences. These are too numerous to list and are available in the University bulletin.

The University also offers graduate programs in Marine Science, Fishery Science, and Ocean Law which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

OCEAN ENGINEERING DEPARTMENT

Compton, Kenneth G., M.S., Professor of Ocean Engineering
DeFerrari, Harry, Ph.D., Assistant Professor of Ocean Engineering
Green, William C., B.S., Research Scientist in Ocean Engineering
Kronengold, Morton, B.S., Associate Professor of Ocean Engineering
Michel, John F., M.S., Associate Professor of Ocean Engineering
Steinberg, John C., Ph.D., Chairman and Professor of Ocean Engineering
Weinberg, Norman L., Ph.D., Associate Professor of Ocean and Electrical Engineering
Yacoub, Kamal, Ph.D., Associate Professor of Ocean and Electrical Engineering

CIVIL ENGINEERING DEPARTMENT

Chang, W. F., Ph.D., Professor of Civil Engineering
Morrow, Bertan W., M.S., Assistant Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

Dr. Norman L. Weinberg
Ocean Engineering Department
University of Miami
Coral Gables, Florida 33124

## INSTITUTE OF ENGINEERING TECHNOLOGY*
### MISSISSIPPI STATE UNIVERSITY
### STATE COLLEGE, MISSISSIPPI

The Institute has well-equipped design and electronic laboratories and computing facilities.

All curriculums at the Institute of Engineering Technology lead to the Bachelor of Engineering Technology degree awarded by Mississippi State University.

The following courses are offered in conjunction with the above program:

MARINE ENGINEERING TECHNOLOGY

| | | |
|---|---|---|
| MAT 2004 | Shipbuilding Technology | 3 |
| MAT 2104 | Marine Engineering Technology | 4 |
| MAT 2603 | Naval Architecture Technology I | 3 |
| MAT 3014 | Shipyard Operations Technology I | 4 |
| MAT 3024 | Shipbuilding Technology II | 4 |
| MAT 3114 | Marine Engineering Technology II | 4 |
| MAT 3123 | Marine Engineering Technology III | 3 |
| MAT 3404 | Shipboard Ventilation | 4 |

| | | |
|---|---|---|
| MAT 3614 | Naval Architecture Technology II | 4 |
| MAT 3623 | Naval Architecture Technology III | 3 |
| GET 2303 | Applied Thermodynamics | 3 |
| GET 2403 | Metals Technology | 3 |
| GET 3313 | Applied Fluid Mechanics | 3 |
| GET 3323 | Applied Dynamics | 3 |

MARINE SCIENCE

| | | |
|---|---|---|
| GET 3023 | Marine Structures | 3 |
| GET 2403 | Oceanography I | 3 |
| GET 2503 | Oceanography II | 3 |
| GET 3003 | Introduction to Underwater Acoustics | 3 |

The instructional staff for the courses listed above consists of the following:

Bartlett, F.G., M.S., P.E., Associate Professor of Marine Engineering Technology
Bryant, Glynn D., M.S., P.E., Assistant Professor of Marine Engineering Technology
Hallock, J.F., M.S., P.E., Associate Professor of Marine Engineering Technology

To obtain further information, address all inquiries directly to:

J. E. Thomas, Director
Institute of Engineering Technology
Drawer GL
State College, Mississippi 39762

*(Formerly Gulf Coast Technical Institute)

## UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE

Ocean engineering at the University of New Hampshire is centered in the Engineering Design and Analysis Laboratory (EDAL). EDAL has committed itself to the task of providing a real-world view of engineering by offering a variety of project-oriented academic experiences to undergraduate and graduate engineering students. Since its beginning four years ago, EDAL has concentrated its efforts on the ocean.

(For a description of other facilities at the University of New Hampshire, please refer to the University's listing in the Marine Science section of this publication.)

The following degrees are offered:

1. Department of Chemical Engineering: B.S., M.S.
2. Department of Civil Engineering: B.S., M.S.
3. Department of Electrical Engineering: B.S., M.S.
4. Department of Mechanical Engineering: B.S., M.S.
5. An interdepartmental engineering Ph.D. program has recently been established at the University of New Hampshire. A candidate may choose one of the following options: Engineering Systems Design, Signal Processing, Solid and Structural Mechanics, or Transport Phenomena. These options offer opportunities for advanced study in ocean engineering.

An Ocean Engineering Minor Program is available to undergraduates. The program cirriculum includes such courses as Introduction to Oceanography, Introduction to Ocean Technology, Physical Oceanography, Geological Oceanography, Naval Architecture in Ocean Engineering, Underwater Acoustics, Applied Hydrodynamics and Coastal Engineering and an Undergraduate Projects Course. Additionally, undergraduates who wish to become more deeply involved in ocean engineering activities may do so by associating themselves with professors and graduate students who are engaged in ocean projects.

The following courses are offered in conjunction with the above programs:

MECHANICAL

| | | |
|---|---|---|
| 751 | Naval Architecture | 4 |
| 808 | Theoretical Aero/Hydro-Mechanics | 4 |

ELECTRICAL - MECHANICAL

| | | |
|---|---|---|
| 695 | Engineering Projects | 2-4 |
| 696 | Engineering Projects | 2-4 |

TECHNOLOGY

| | | |
|---|---|---|
| 780 | Engineering Analysis | 2-3 |

CHEMICAL, CIVIL, ELECTRICAL, MECHANICAL

| | | |
|---|---|---|
| 899 | Master's Thesis | 1-6 |

The University also offers undergraduate and graduate programs in Marine Sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Allmendinger, E. Eugene, M.S., Associate Professor of Mechanical Engineering
Azzi, Victor D., Ph.D., Associate Professor of Mechanics
Blanchard, Fletcher, A., Jr., M.S., Professor of Electrical Engineering
Corell, Robert W., Ph.D., Chairman and Professor of Mechanical Engineering
Glanz, Filson, Ph.D., Assistant Professor of Electrical Engineering
Klotz, Louis H., Ph.D., Assistant Professor of Civil Engineering
Murdoch, Joseph B., Ph.D., Chairman and Professor of Electrical Engineering
Pokoski, John, Ph.D., Assistant Professor of Electrical Engineering
Savage, Godfrey H., Engineer, Director of EDAL and Professor of Mechanical Engineering
Skutt, H. Richard, Ph.D., Associate Professor of Electrical Engineering
Stolworthy, E. Howard, B.S., Professor Mechanical Engineering
Taft, Charles K., Ph.D., Professor of Mechanical Engineering
Winn, Alden L., M.S., Professor of Electrical Engineering
Yildiz, Asim, D. Eng., Professor of Mechanics
Zimmerman, Oswald T., Ph.D., Chairman and Professor of Chemical Engineering

To obtain further information, address all inquiries directly to:

Office of Marine Science and Technology
Kingsbury Hall
University of New Hampshire
Durham, New Hampshire 03824

## NORTHEASTERN UNIVERSITY
BOSTON, MASSACHUSETTS

(For a description of the facilities and the marine science program at the Northeastern University, please refer to the University's listing in the Marine Sciences section of this publication.)

The following degrees are offered:

1. B.S. in Civil Engineering.
2. B.S. in Mechanical Engineering.
3. M.S. in Civil Engineering. (Sanitary Engineering)
4. M.S. in Mechanical Engineering. (Ocean Engineering)

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

UNDERGRADUATE

DEPARTMENT OF CIVIL ENGINEERING

| | | |
|---|---|---|
| 1.122 | Hydraulic Engineering | 4 |
| 1.193 | Environmental Engineering I | 4 |
| 1.194 | Environmental Engineering II | 4 |

DEPARTMENT OF MECHANICAL ENGINEERING

| | | |
|---|---|---|
| 02.155 | Fluid Mechanics | 4 |
| 02.156 | Fluid Mechanics II | 4 |

GRADUATE

GRADUATE SCHOOL OF ENGINEERING

| | | |
|---|---|---|
| 01.910 | Water and Waste Treatment I | 2 |
| 01.911 | Water and Waste Treatment II | 2 |
| 01.912 | Water and Waste Treatment III | 2 |
| 01.95; | Radiological Health Engineering | 2 |
| 01.954 | Stream Sanitation | 2 |
| 02.870 | Ocean Enigneering I | 2 |
| 02.871 | Ocean Engineering II | 2 |
| 02.873 | Geophysical Engineering | 2 |
| 02.874 | Ocean Measurements | 2 |

The University also offers graduate programs in Marine Sciences which are described in the Marine Sciences section of this publication.

The instructional staff for the courses listed above consists of the following:

Blanc, Frederic, Ph.D., Assistant Professor of Civil Engineering
Gregory, Constatine, Ph.D., Assistant Professor in Environmental Science
Meserve, Robert, M.S.C.E., Associate Professor of Civil Engineering
Parker, Gerald M.S., Lecturer in Civil Engineering
Phalen, Thomas E., M.S., Associate Professor in Mechanical Engineering
Spiegel, Stanley, Ph.D., Research Assistant in Mathematics
Thomas, Lloyd G. D., Ph.D., Lecturer in Mechanical Engineering

To obtain further information, address all inquiries directly to:

UNDERGRADUATE ENGINEERING

Dean Thomas Hulbert
Northeastern University
Boston, Massachusetts 02115

GRADUATE ENGINEERING

Dean George Hankinson
Northeastern University
Boston, Massachusetts 02115

## OREGON STATE UNIVERSITY
CORVALLIS, OREGON

The School of Engineering offers Ocean Engineering courses and conducts research programs on the main campus of Oregon State University at Corvallis, Oregon and also at the Marine Science Center at Newport, Oregon. The facilities available to the Ocean Engineering program include a Hydraulics Laboratory, Sanitary Engineering Laboratory, Photogrammetry Laboratory, Solid Mechanics Laboratory, Structural Engineering Laboratory, Engineering Materials Laboratory, Mechanical Engineering Laboratory, Instrumentation Laboratory, Electro-Chemical Engineering Laboratory, Underwater Acoustics Laboratory, Simulation Laboratory (with an EAI 690 Hybrid Computer). The University has a well developed Computer Center with CDC 3300 computers at 50 locations throughout the campus.

The following degrees are offered by the School of Engineering:

1. Doctor of Philosophy. Students interested in a Doctor of Philosophy degree in Ocean Engineering may obtain this in any of the departments in the School of Engineering. The student's program is an integrated program involving a Minor in Oceanography, a Major in an Engineering discipline, and research related to a problem in Ocean Engineering. The student's program is approved by his subject matter department and an Ocean Engineering Committee of the School of Engineering. Requirements for the Ph.D. are identical to requirements of all Ph.D.'s in Engineering at Oregon State University.
2. Master of Ocean Engineering. The Master of Ocean Engineering is a designated degree administered on an interdepartmental basis by a School of Engineering Committee. The degree requires 45 credit hours including research. A major field of study in one field of Engineering and a Minor in Oceanography are normally required.
3. Master of Science. The Master of Science degree requires 45 credit hours including research. Normally the program includes a Minor in Oceanography, a major in one of the Engineering disciplines, and research oriented to some Ocean Engineering problem.

The following courses are offered in conjunction with the above programs:

GRADUATE

| | |
|---|---|
| CE 524 | Sediment Transport |
| CE 566 | Ocean Position Surveying |
| CE 570 | Coastal Hydraulics |
| CE 572 | Marine Water Quality Dynamics |
| CE 574 | Ocean Engineering Facilities Planning |
| CE 578 | Marine Geo-technic |
| CE 579 | Special Topics in Ocean Engineering |
| EE 507 | Systems Instrumentation Seminar |
| EE 507 | Ultrasonics Seminar |
| EE 560 | Signals and Noise |
| EE 561 | Communication Systems |
| ME 505 | Ocean Systems Engineering |

The above courses are directly related to the Ocean Engineering program. Numerous other courses are available which provide the basic support for the above courses.

The University also offers undergraduate and graduate programs in Food Science and Technology and graduate programs in Marine Sciences and Fisheries Science which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CHEMICAL ENGINEERING

Meredith, R. E., Ph.D., Professor
Wicks, C. E., Ph.D., Professor and Head of Department

DEPARTMENT OF CIVIL ENGINEERING

Bella, David A., Ph.D., Assistant Professor
Burgess, F.J., Acting Dean of Engineering, Head of Department
Filmer, R. W., Ph.D., Assistant Professor
Klingeman, P.C., Ph.D., Associate Professor
Schaumburg, F. D., Ph.D., Associate Professor
Slotta, L. S., Ph.D., Associate Professor
Schroeder, W. L., Ph.D., Associate Professor

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Jensen, L. C., M.S., Associate Professor
Michael, R. R., M.S., Associate Professor
Saugen, J. L., Ph.D., Associate Professor
Stone, L. N., M.S., Professor and Head of Department
Weber, L. J., M.S., Professor

DEPARTMENT OF INDUSTRIAL ENGINEERING

Engesser, W. F., M.S., Professor
Inoue, M. S., Ph.D., Associate Professor
Riggs, J. L., Ph.D. Professor and Head of Department

DEPARTMENT OF MECHANICAL ENGINEERING

Dahlke, H. J., Ph.D., Associate Professor
Davis, L. R., Ph.D., Associate Professor
Smith, C. E., Ph.D., Associate Professor
Welty, J. R., Ph.D., Professor and Acting Head of Department
Wilson, R. E., Ph.D., Professor
Zaworski, R. J., Ph.D., Professor

DEPARTMENT OF METALLURGICAL ENGINEERING

McComb, J. A., Ph.D., Assistant Professor
Olleman, R. D., Ph.D., Professor and Head of Department
Paasche, O. G., M.S., Professor

To obtain further information, address all inquiries directly to:

James G. Knudsen
Assistant Dean of Engineering
Engineering Experiment Station
Oregon State University
Corvallis, Oregon 97331

## UNIVERSITY OF RHODE ISLAND
### KINGSTON, RHODE ISLAND

The Department of Ocean Engineering operates two motor boats which are used for research in Narragansett Bay. The shore facilities and ship facilities of the Graduate School of Oceanography are available to ocean engineering faculty and graduate students. In addition, the College of Engineering laboratories include a well-equipped soils and sediments laboratory, an underwater acoustics laboratory in a new building, a sub-critical reactor, many wave and model tanks in the several engineering buildings. Nearby Navy and industrial laboratories have made many of their facilities available for cooperative research work.

The following degrees are offered by the University:

1. Master of Science in Ocean Engineering.
2. Doctor of Philosophy in Ocean Engineering.

The following courses are offered in conjunction with the above programs:

| | |
|---|---|
| OCE 434 | Corrosion and Corrosion Control |
| OCE 457 | Fluidics |
| OCE 512 | Hydrodynamics of Floating and Submerged Bodies I |
| OCE 513 | Hydrodynamics of Floating and Submerged Bodies II |
| OCE 531 | Underwater Power Systems |
| OCE 532 | Coastal Zone Power Plants |
| OCE 540 | Environmental Control in Ocean Engineering |
| OCE 561 | Introduction to the Analysis of Oceanographic Data |
| OCE 571 | Underwater Acoustics I |
| OCE 587 | Submarine Soil Mechanics |
| OCE 591 | Special Problems - Ocean Engineering Analysis |
| OCE 591A | Special Problems - Ocean Instrumentation |
| OCE 592A | Advanced Corrosion Engineering |
| OCE 605 | Ocean Engineering Seminar |
| OCE 606 | Ocean Engineering Seminar |
| OCE 610 | Engineering Ocean Mechanics |
| OCE 622 | Analysis of Oceanographic Data Systems |
| OCE 653 | Ocean Engineering Systems Studies |
| OCE 654 | Ocean Engineering Systems Studies |
| OCE 672 | Underwater Acoustic Propagation I |
| OCE 691 | Special Problems |

The University also offers graduate programs in marine sciences and an associate program in fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Brown, G. A., Sc.D., Professor
Middleton, F. H., Dr.Eng., Chairman and Professor
Nacci, V. A., M.S., Professor
Schenck, H. Van N., Jr., M.S., Professor
Sheets, H. E., Sc.D., Professor
White, F.M., Jr., Ph.D., Professor

Haas, R. B., M.S., Associate Professor
Kowalski, T., Ph.D., Associate Professor
Rose, V. C., Ph.D., Associate Porfessor
Stanislao, J., M.S., Associate Professor
Moffett, M.B., Ph.D., Assistant Professor
Soltz, G. C., Ph.D., Assistant Professor

To obtain further information, address all inquiries directly to:

F. H. Middleton, Chairman
Ocean Engineering Department
College of Engineering
University of Rhode Island
Kingston, Rhode Island 02881

## RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
### NEW BRUNSWICK, NEW JERSEY
### CAMDEN, NEW JERSEY
### NEWARK, NEW JERSEY

(For a description of the facilities at Rutgers, please refer to the University's listing in the Marine Sciences section of this publication.)

A marine emphasis is available in the undergraduate programs in the Engineering departments.

A Master's degree program in Ocean Engineering is currently getting underway. This will require practical research experience in the marine area and courses, such as 990-506 Coastal Oceanography, 180-590 Coastal Engineering, 180-588 Theory of Hydraulic Models and 650-539 Mechanics of Real Fluids.

The following courses are offered in conjunction with the above programs:

GRADUATE COURSES

DEPARTMENT OF CIVIL ENGINEERING

| | |
|---|---|
| 180-588 | Theory of Hydraulic Models |
| 180-590 | Coastal Engineering |

DEPARTMENT OF MECHANICAL ENGINEERING

| | |
|---|---|
| 650-515 | Fluid Dynamics I |
| 650-516 | Fluid Dynamics II |
| 650-517 | Heat and Mass Transfer I |
| 650-518 | Heat and Mass Transfer II |
| 650-539 | Mechanics of Real Fluids |
| 650-621 | Theory of Turbulence |
| 650-622 | Atmospheric Turbulence |

The University also offers undergraduate and graduate programs in Marine Sciences which are described in the Marine Sciences section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL ENGINEERING

Bourodimos, Efstathios L., Ph.D., Associate Professor of Civil Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Briggs, David G., Ph.D., Associate Professor of Mechanical Engineering
Chen, Chuan Fang, Ph.D., Professor of Aerospace Engineering
Peskin, Richard L., Ph.D., Professor of Mechanical Engineering
Przirembel, Christian E. G., Ph.D., Assistant Professor of Aerospace Engineering

To obtain further information, address all inquiries directly to:

Louis A. Rosenthal
Department of Electrical Engineering
Rutgers University
New Brunswick, New Jersey 08903

## SOUTHEASTERN MASSACHUSETTS UNIVERSITY
### NORTH DARTMOUTH, MASSACHUSETTS

The University owns a 66-foot research vessel, the CORSAIR. Her equipment includes radar, loran, recording echo sounder, radio telephone, 12-foot stern-mounted "A" frame, and a double drum winch equipped with a six-wire slip ring assembly.

The following degrees are offered by the Departments of Electrical Engineering, Mechanical Engineering, and Civil Engineering, respectively:

1. B.S. in Electrical Engineering (Ocean Option). The student electing the ocean option in electrical engineering is required to take a six course sequence in ocean science and engineering as part of his curriculum. The required courses are: OE 395/6, OE 495/6, OE 491, and OE 494.
2. B.S. in Mechanical Engineering (Ocean Option). The student electing the ocean option in mechanical engineering is required to take a six course sequence in ocean science and engineering as part of his curriculum. The required courses are: OE 395/6, OE 495/6, OE 492, and OE 494
3. B.S. in Civil Engineering (Ocean Option). The student electing the ocean option in civil engineering is required to take a six course sequence in ocean science and engineering. The required courses are: OE 395/6, OE 495/6, and OE 497/8.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

| | | |
|---|---|---|
| OE 395 | Physical Oceanography I | 3 |
| OE 396 | Physical Oceanography II | 3 |
| OE 491 | Underwater Acoustics | 3 |
| OE 492 | Ocean Waves | 3 |
| OE 494 | Ocean Instrumentation | 3 |
| OE 495 | Fundamentals of Ocean Engineering I | 3 |
| OE 496 | Fundamentals of Ocean Engineering II | 4 |
| OE 497 | Marine Geology I | 3 |
| OE 498 | Marine Geology II | 3 |

The University also offers undergraduate and graduate programs in Marine Sciences which are described in the Marine Sciences section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF ELECTRICAL ENGINEERING

Crocker, Kimball, M.S., Instructor in Electrical Engineering (part time)
Fain, Gilbert, Ph.D., Associate Professor of Electrical Engineering
Gonsalves, Lenine, M.S., Professor of Electrical Engineering
Massey, Allen, M.S., Visiting Lecturer (part time)
Morton, Robert, M.A., Instructor in

Electrical Engineering (part time)
Shonting, David, Sc.D., Associate Professor of Electrical Engineering (part time)

To obtain further information, address all inquiries directly to:

Dean, College of Engineering
Southeastern Massachusetts University
North Dartmouth, Massachusetts 02747

## UNIVERSITY OF SOUTHERN CALIFORNIA
## UNIVERSITY PARK
### LOS ANGELES, CALIFORNIA

(For a description of the facilities and the marine science program at the University of Southern California, please refer to the University's listing in the Marine Sciences section of this publication.)

The University offers the M.S. degree in Ocean Engineering from the Department of Aerospace Engineering. The basic prerequisite for this degree is a B.S. degree in Engineering.

The following courses are offered in conjunction with the above program:

DEPARTMENT OF AEROSPACE ENGINEERING

UNDERGRADUATE COURSE

| | | |
|---|---|---|
| 470 | Man's Influence on his Environment, Pollution and Control | 4 |

GRADUATE COURSES

| | | |
|---|---|---|
| 510ab | Dynamics of Incompressible Fluids | 4 |
| 616 | Ocean Measurements | 4 |
| 620 | Aero and Hydrodynamic Wave Theory | 4 |
| 621 | Stability of Fluids | 4 |
| 623ab | Dynamics of Stratifield and Rotating Flows | 4 |
| 624ab | The Fluid Dynamics of Natural Phenomena | 4 |
| 625 | Laminar Boundary Layer Theory | 4 |
| 652 | Turbulent Shear Flows | 4 |

The University also offers undergraduate and graduate programs in marine sciences which are described in the Marine Sciences section of this publication.

The University also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF AEROSPACE ENGINEERING

Laufer, John, Ph.D., Chairman and Professor of Turbulence and Chairman, Division of Engineering and Applied Mechanics
Maxworthy, Tony, Ph.D., Professor of Geophysical Fluid Mechanics and Low Speed Aerodynamics
Troesch, B. Andreas, Ph.D., Professor of Applied Mathematics

DEPARTMENT OF CIVIL ENGINEERING

Bowerman, F. R., Ph.D., Professor of Environmental Engineering
Browand, Fred K., Ph.D., Assistant Professor of Hydrology
Butler, Stanley S., M.S., Associate Professor of Hydrology
Chen, Kenneth Y., Ph.D., Assistant Professor of Environmental Engineering
Lee, J. J., Ph.D., Visiting Assistant Professor of Ocean Engineering
Masri, Sami F., Ph.D., Associate Professor of Structural Mechanics

DEPARTMENT OF MECHANICAL ENGINEERING

Binder, Raymond C., Ph.D., Professor of Underwater Acoustics, Fluid Mechanics, and Vibrations
Siegel, Martin J., M.S., Associate Professor of Mechanical Design, Stress Analysis, and Materials

To obtain further information, address all inquiries directly to:

Dr. Bernard C. Abbott
Director, Allan Hancock Foundation
University of Southern California
University Park
Los Angeles, California 90007

## STEVENS INSTITUTE OF TECHNOLOGY
### HOBOKEN, NEW JERSEY

The Davidson Laboratory is the center for research in ocean engineering at Stevens. The major facilities include: (1) a 130-foot towing tank suitable for model studies of ships and other structures in regular and irregular seas; (2) a 75-foot square basin for model tests on course stability and maneuvering characteristics of ships and submersibles; and (3) a 300-foot towing tank for high speed testing; (4) an enclosed wind tunnel with 2.5 x 3.5 x 12-foot test section and with a maximum wind speed capability of 200 feet/second. Stevens has recently purchased and renovated a former luxury liner for use as a dormitory, permanently moored in the Hudson River immediately adjacent to the campus. A small oceanographic laboratory is being established aboard this ship. A 26-foot catamaran is also available for field work in the adjacent rivers and bays.

The following degrees are offered:

1. Doctor of Philosophy. The program leading to the Doctor of Philosophy degree is designed to develop the student's capability to perform basic research or high level design in ocean engineering. All students entering the doctoral program must have a master's degree or equivalent. Students who have not earned their master's degrees in the Department of Ocean Engineering must take all the courses required for the Master of Engineering (Ocean) degree or must have satisfactorily completed comparable courses in other institutions. In addition to having completed the above requirements, all doctoral candidates must pass the qualifying examination which includes not only an oral examination to test the student's capability for advanced study, but also an evaluation of his ability to write effectively. The student may demonstrate his writing ability by presenting either an acceptable master's thesis or a critical review of several technical articles dealing with some aspect of ocean engineering. Doctoral candidates are expected to concentrate their advanced grad-

uate studies in one of the areas of specialization presently offered in the department: Free Structures in the Ocean, Fixed Structures in the Ocean, or Underwater Acoustics. A fourth area of specialization, Pollution Control, is under development. Additional courses in the Department of Electrical Engineering, Mathematics and Mechanical Engineering are taken by the student to complete his program.

2. Master of Engineering (Ocean). A program of study leading to a master's degree should contain at least eight courses in ocean engineering. Five courses, which are considered basic to all areas within this field of study, are OE 101, OE 102, OE 103, OE 200, and OE 203. The remaining credits required for the master's degree can be obtained by either taking additional course work in a particular area of concentration or by additional course work and writing a master's thesis.

The following courses are offered in conjunction with the above programs:

GRADUATE COURSES

DEPARTMENT OF OCEAN ENGINEERING

| | | |
|---|---|---|
| OE 101 | Oceanography I | 2.5 |
| OE 102 | Oceanography II | 2.5 |
| OE 103 | Seminar in Ocean Engineering | 2.5 |
| OE 105 | Transducers | 2.5 |
| OE 125 | Principles of Naval Architecture I | 2.5 |
| OE 127 | Laboratory in Naval Architecture | 2.5 |
| OE 141 | Acoustics | 2.5 |
| OE 143 | Acoustics Laboratory | 2.5 |
| OE 150 | Stochastic Marine Processes | 2.5 |
| OE 200 | Fluid Dynamics for Ocean Engineering | 2.5 |
| OE 201 | Theoretical and Applied Hydrodynamics | 2.5 |
| OE 203 | Dynamic Oceanography I | 2.5 |
| OE 220 | Dynamics of Ocean Waves | 2.5 |
| OE 221 | Motion of Vessels in Waves | 2.5 |
| OE 222 | Stability and Control of Marine Craft | 2.5 |
| OE 223 | Design of Marine Propulsors | 2.5 |
| OE 224 | Hydrodynamics of High-Speed Marine Craft I | 2.5 |
| OE 231 | Vibrational Response of Ocean Structures | 2.5 |
| OE 232 | Special Topics in Corrosion | 2.5 |
| OE 240 | Underwater Acoustics I | 2.5 |
| OE 242 | Air-Sea Interactions: Theory and Measurement | 2.5 |
| OE 243 | Special Topics in Ocean Instrumentation | 2.5 |
| OE 244 | Acoustic Signal Processing | 2.5 |
| OE 246 | Underwater Acoustics II | 2.5 |
| OE 250 | Optimal Control for Marine Systems | 2.5 |
| OE 251 | Optimal Estimation for Ocean Engineers | 2.5 |
| OE 400 | Special Problems | 1-3 |
| OE 401 | Special Problems | 1-3 |
| OE 500 | Thesis in Ocean Engineering (Master's) | 5 |
| OE 600 | Research in Ocean Engineering (Ph.D.) | |

DEPARTMENT OF MECHANICAL ENGINEERING

| | | |
|---|---|---|
| ME 274 | Fluid Dynamics | 2.5 |
| ME 278 | Viscous and Turbulent Flows | 2.5 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF OCEAN ENGINEERING

Arase, Elizabeth M., Ph.D., Associate Professor of Ocean Engineering
Arase, Tetsuo, Ph.D., Associate Professor of Ocean Engineering
Breslin, John P., D.Sc., Chairman and Professor of Ocean Engineering
Davies, Thomas V., Ph.D., Visiting Lecturer in Ocean Engineering
Eda, Haruzo, D.Sc., Visiting Lecturer in Ocean Engineering
Henry, Charles J., D.Sc., Research Associate Professor of Ocean Engineering
Hires, Richard I., Ph.D., Assistant Professor of Ocean Engineering
Kim, Cheung Hun, Dr. Ing., Visiting Lecturer in Ocean Engineering
Mercier, John A., M.S., Visiting Lecturer in Ocean Engineering
Numata, Edward, M.S., Research Associate Professor of Ocean Engineering
Savitsky, Daniel, M.S., Associate Professor of Ocean Engineering
Strumpf, Albert, Ph.D., Research Associate Professor of Ocean Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Nickerson, Richard J., D.Sc., Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Dr. Richard I. Hires
Department of Ocean Engineering
Stevens Institute of Technology
Castle Point Station
Hoboken, New Jersey 07030

## TEXAS A&M UNIVERSITY
### COLLEGE STATION, TEXAS

The Coastal Engineering Laboratory was established in February, 1969. The main purpose of the Laboratory is to study the major Gulf Coast Bays and Estuaries. The Laboratory has exceptional facilities for research and teaching. There is a 120 foot long, 3 foot deep and 2 foot wide two-dimensional wave tank in which mechanically and/or wind-generated wave phenomena may be investigated. Also, currents may be generated in either direction along the tank. A 150 foot long, 5 foot wide, and 10 foot deep two-dimensional combination wave and towing tank is nearing completion.

There is a 16 foot long, 4 foot wide and 8 inch deep ripple tank in which three-dimensional wave phenomena (refraction, diffraction, etc.) may be demonstrated or further investigated.

There is a 150 foot long, 4 foot wide and 2 foot deep variable slope recirculating flume with a discharge capacity of 20 cfs which may be used for sediment transport studies, boundary resistance, scour of submerged pipelines, etc.

A three-dimensional wave-sediment basin (32 foot by 86 foot by 2 foot 6 inches deep) which contains tide and portable wave generators and water supply lines to generate currents has been constructed. This tank may be used to perform harbor and estuary model studies, to study wave

refraction and diffraction phenomena, to study coastal sediment littoral drift and erosion, etc.

Also, there is a 41 foot wide by 18 inches deep by 8 inches wide combination wave/current flume that may be used for open channel or wave research. This flume has a variable slope.

The Center for Dredging Studies was established in June, 1968, in view of renewed interest in greater utilization and exploitation of minerals from the ocean floor and increased activities in estuaries along the shore, and offshore. The primary objectives of the Center are teaching, research and development and information dissemination.

The Environmental Engineering Division of the Civil Engineering Department of Texas A&M University carries out a broad teaching and research program in Environmental Engineering in general and in Estuarine Water Quality Management in particular.

The Division operates the RV/EXCELLENCE. This 55-foot twin diesel vessel and a companion 50-foot vessel, the RV/MARINER, are presently operated from a field Water Pollution Research Laboratory at Morgan's Point near Houston, Texas. Other divisional facilities include water quality laboratories on the College Station Campus and a Water Reclamation Center operated in Dallas, Texas, in conjunction with the City of Dallas.

The Division's research program includes such areas as analytical water quality models for coastal and estuarine areas, evaluation of pollutant and quality parameter mass balances in coastal aquatic systems, water quality management methods, reaeration, hazardous material control, advanced waste treatment and water reclamation, Industrial Waste Treatment and Water Resources Management.

The following degrees are offered by the Civil Engineering Department:

1. Ph.D. in Civil Engineering with major in Coastal and Ocean Engineering. The doctoral degree program requires a minimum of six full semesters of acceptable advanced study. A reading knowledge of at least one foreign language is required. The student must pass a preliminary examination given by his graduate committee and a final defense of the dissertation.

2. M.S. in Civil Engineering with major in Coastal and Ocean Engineering. The Master of Science degree program requires a minimum of two full semesters of approved courses and research (32 semester hours). This requirement is ordinarily met by completing at least 24 hours of course work and up to eight hours of research. An acceptable thesis is required which should embody original work. The student is required to pass a final examination, covering his graduate programs, which is administered by the student's graduate committee and may be either written or oral.

3. M.E. in Civil Engineering with major in Coastal and Ocean Engineering. The Master of Engineering degree requires a minimum of 36 semester hours of which one third will be taken in fields other than the major field. A thesis is not required for this degree. With these exceptions, the requirements are the same as those for the Master of Science degree.

4. Ph.D. in Civil Engineering with major in Environmental Engineering and Environmental Science. The doctoral degree program requires a minimum of six full semesters of acceptable advanced study. A reading knowledge of at least one foreign language is required. The student must pass a preliminary examination given by his graduate committee and a final defense of the dissertation.

5. M.S. in Civil Engineering with major in Environmental Engineering and environmental Science. The Master of Science degree program requires a minimum of two full semesters of approved courses and research (32 semester hours). This requirement is ordinarily met by completing at least 24 hours of course work and up to eight hours of research. An acceptable thesis is required which should embody original work. The student is required to pass a final examination, covering his graduate programs, which is administered by the student's graduate committee and may be either written or oral.

6. M.E. in Civil Engineering with major in Environmental Engineering and Environmental Science. The Master of Engineering degree requires a minimum of 36 semester hours of which one third will be taken in fields other than the major field. A Thesis is not required for this degree. With these exceptions, the requirements are the same as those for the Master of Science degree.

The following courses are offered in conjunction with the above programs:

COASTAL AND OCEAN ENGINEERING

| | | |
|---|---|---|
| C.E. 667 | Coastal Engineering II | 4 |
| C.E. 675 | Coastal Engineering I | 3 |
| C.E. 676 | Ocean Engineering I | 3 |
| C.E. 677 | Coastal Engineering II | 3 |
| C.E. 682 | Coastal Sediment Processes | 3 |
| C.E. 683 | Estuary Hydrodynamics | 3 |
| C.E. 684 | Shallow and Deep Water Dredging | 3 |
| C.E. 685 | Problems | |
| | Coastal Sediment Processes | 1-6 |
| | Estuary Hydrodynamics | 1-6 |
| | Shallow and Deep Ocean Dredging | 1-6 |
| C.E. 686 | Ocean Structures Engineering | 3 |
| C.E. 687 | Marine Foundation Engineering | 3 |

ENVIRONMENTAL ENGINEERING

| | | |
|---|---|---|
| C.E. 301 | Water and Sewage Treatment | 3 |
| C.E. 402 | Water Supply and Sewerage Practice | 3 |
| C.E. 603 | Stream Quality | 3 |
| C.E. 604 | Introducation to Unit Operation Theory | 3 |
| C.E. 605 | Experimental Analysis in Environmental Engineering | 3 |
| C.E. 606 | Design of Waste Water Treatment systems | 3 |
| C.E. 607 | Environmental Analysis for Urban Areas | 3 |
| C.E. 608 | Environmental Design for Urban Areas | 3 |
| C.E. 609 | Simulation of Water Resources Systems for Numerical Analysis | 3 |
| C.E. 610 | Industrial Wastes | 3 |
| C.E. 664 | Water Resources Development | 3 |
| C.E. 680 | Civil Engineering Computer Systems | 3 |

FLUID MECHANICS, HYDROLOGY AND HYDRAULIC ENGINEERING

| | | |
|---|---|---|
| C.E. 458 | Hydraulic Engineering | 3 |
| C.E. 462 | Hydromechanics | 3 |
| C.E. 463 | Hydrology | 3 |
| C.E. 622 | Hydraulics of Drainage Structures | 2 |
| C.E. 627 | Hydrology | 3 |
| C.E. 628 | Hydraulic Engineering | 3 |
| C.E. 629 | Hydraulics of Open Channels | 3 |
| C.E. 674 | Flow Through Porous Media | 3 |
| C.E. 678 | Hydromechanics | 3 |
| C.E. 679 | Theory of Fluid Mechanics Models | 2 |

AEROSPACE ENGINEERING

| | | |
|---|---|---|
| Aero 320 | Numerical Methods | 3 |
| Aero 475 | Aerodynamics of Viscous Fluids | 3 |
| Aero 601 | Principles of Fluid Motion | 4 |

MECHANICAL ENGINEERING

| | | |
|---|---|---|
| M.E. 621 | Fluid Mechanics | 4 |

The University also offers graduate programs in various aspects of Marine Sciences which are described in the Marine Sciences section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL ENGINEERING

COASTAL AND OCEAN ENGINEERING DIVISION

Dominguez, Richard F., Ph.D., Assistant Professor of Civil Engineering
Herbich, John B., Ph.D., Division Head and Professor of Civil Engineering
Sorensen, Robert M., Ph.D., Associate Professor of Civil Engineering

The following faculty members from other Divisions of the Civil Engineering Department and from various Departments of the University teach special courses in Coastal and Ocean Engineering and Oceanography and are generally concerned with the program.

Basco, David R., Ph.D., Assistant Professor of Civil Engineering, Hydraulics and Fluid Mechanics Division
Coyle, Harry M., Ph.D., Associate Professor, Soil Mechanics Division
Davis, William B., Sc.D., Associate Professor of Civil Engineering, Environmental Division
Hann, Roy W., Ph.D., Associate Professor of Civil Engineering, Environmental Division
Lowery, Lee L., Ph.D., Associate Professor of Civil Engineering, Structural Engineering Division
Reid, Robert O., M.S., Professor of Oceanography and Civil Engineering
Schiller, Robert E., Ph.D., Associate Professor of Civil Engineering, Hydraulics and Fluid Mechanics Division

ENVIRONMENTAL ENGINEERING AND ENVIRONMENTAL SCIENCE DIVISION

Hann, Roy W., Jr., Ph.D., Division Head and Associate Professor
Hughes, J. Martin, M.S., Assistant Professor
Irvine, Robert L., Jr., Ph.D., Assistant Professor
Kramer, Gary R., Sc.D., Assistant Professor
Langley, William D., Ph.D., Assistant Professor
Reynolds, Tom D., Ph.D., Associate Professor
Wolf, Harold, Ph.D., Professor

The following faculty members from other Divisions of the Civil Engineering Department and from various Departments of the University teach supporting courses in Environmental Engineering and are generally concerned with the program.

Baldauf, Richard J., Ph.D., Wildlife Science
Clark, Robert A., Ph.D., Hydrometeorology
Clark, William J., Ph.D., Biology
Giam, C. S., Ph.D., Chemistry
Herbich, John, Ph.D., Head, Fluid Mechanics and Coastal and Ocean Engineering
Meier, Wilbur, Ph.D., Industrial Engineering
Runkles, J. R., Ph.D., Director, Water Resources Institute
Taber, Willard, Ph.D., Microbiology

To obtain further information, address all inquiries directly to:

Dr. John B. Herbich
Hydrodynamic Laboratory
Texas A&M University
College Station, Texas 77843

Dr. Roy W. Hann, Jr.
Head, Environmental Engineering Division
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

## THE UNIVERSITY OF TEXAS AT AUSTIN
### AUSTIN, TEXAS

The College of Engineering laboratories are well-equipped for ocean engineering research. Modern facilities and instrumentation are available for work in ocean hydrodynamics, structures, soils, saline water conversion, underwater acoustics, and nuclear engineering. Numerous supporting laboratories are also available throughout the College. In addition, there are the facilities of The University of Texas Institute of Marine Science at Port Aransas which maintains a fleet of boats particularly suitable for ocean research in nearshore and estuarine waters.

The University offers the following degrees:

1. Master of Science in Aerospace Engineering and Engineering Mechanics, Chemical, Civil, Electrical, Environmental Health, Mechanical, and Petroleum Engineering. The program leading to the degree of Master of Science is not fixed but is developed in conferences between the student, the graduate faculty of the department in which the student elects to receive the degree, and a member of the Ocean Engineering Committee. Administrative procedures are handled through the graduate advisor of the department. The M.S. degree requires at least 30 semester hours of work beyond the

B.S. degree, six hours of which are usually for a thesis. The specific requirements for the M.S. degree in each department may be found in the Graduate Catalog.

2. Doctor of Philosophy in Aerospace Engineering and Engineering Mechanics, Chemical, Civil, Electrical, Mechanical, and Petroleum Engineering. The program leading to the degree of Doctor of Philosophy is worked out between the student, a member of the Ocean Engineering Committee, and the departmental Committee on Graduate Studies. Students seeking this degree are expected to have well developed ideas about their goals in graduate study and to a large extent the Ph.D. program is adjusted to the student's interests consistent with general requirements of The University of Texas. The residence, foreign language, and other detailed requirements for the Ph.D. degree may be found in The University of Texas Graduate Catalog.

The Ocean Engineering Program at The University of Texas at Austin is interdisciplinary and combines a basic knowledge of the ocean with engineering specialties for the utilization of the resources of the sea and its boundary. The program is based on a number of core courses with the specific coastal and marine applications and supporting work with application to oceanic systems. Study in Ocean Engineering provides a balanced program including course work, individual study and research. By electing courses from across departmental lines, individual programs can be set up in areas such as coastal and estuarine engineering, foundations and construction, mechanical and thermal systems, acoustics, communications and control systems, and ocean resources.

Courses in ocean engineering are offered during the regular year at the main campus of The University of Texas by the Departments of Aerospace and Engineering Mechanics, Chemical, Civil, Electrical, Mechanical, and Petroleum Engineering. Courses are also available at The University of Texas Institute of Marine Science at Port Aransas, Texas. A College-wide committee coordinates Ocean Engineering activities at The University of Texas and is available for advising students with their programs.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF AEROSPACE ENGINEERING AND ENGINEERING MECHANICS

GRADUATE COURSES

ASE396.22 Man-System Engineering
ASE396.28 Hydronautics

DEPARTMENT OF CHEMICAL ENGINEERING

UNDERGRADUATE COURSE

ChE 365 Water Treatment Engineering: Corrosion

GRADUATE COURSE

ChE 381M Transport Operations

DEPARTMENT OF CIVIL ENGINEERING
(Including Atmospheric Sciences and Environmental Health Engineering)

UNDERGRADUATE COURSE

MET 376 Physical Oceanography

GRADUATE COURSES

CE397.22 Special Studies in Ocean Engineering
CE380K.3 Functional Design of Coastal Structures
CE380M.5 Coastal Engineering
CE397.24 Estuarine Engineering
CE394.1 Interaction of Soils and Structures:Selected Problems
CE394.2 Interaction of Soils and Structures: Methods of Analysis
CE396M.31 Atmospheric Turbulence
CE396M.32 Atmospheric Boundary Layers
CE396M.6 Advanced Dynamic Meteorology
CE397.54 Streams and Estuaries
CE397.52 Marine Sciences for Engineers
CE385L Water Resources: Water Quality Improvement

DEPARTMENT OF ELECTRICAL ENGINEERING

UNDERGRADUATE COURSE

EE379K.14 Introduction to Engineering Acoustics

GRADUATE COURSES

EE381J Random Processes in Physical Systems
EE384L.1 Waves in Material Media
EE397K.3 Engineering Acoustics

DEPARTMENT OF MECHANICAL ENGINEERING

UNDERGRADUATE COURSE

ME397M Introduction to Engineering Acoustics (Same as EE397K.14)

GRADUATE COURSES

ME385Q.2 Acoustical Field Theory
ME385Q.3 Ocean Sound Propagation
ME389Q.2 Design of Nuclear Systems
ME397.40 Oceanic Transport Phenomena
ME389Q.4 Similitude and Model Design

DEPARTMENT OF PETROLEUM ENGINEERING

PE383.6 Rock Mechanics I
PE383.8 Rock Mechanics II
PE383.4 Offshore Drilling and Production Operations
PE383.2 Advanced Well Logging and Correlation

The University also offers a graduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF AEROSPACE ENGINEERING AND ENGINEERING MECHANICS

Bertin, J.J., Ph.D., Assistant Professor
Konecci, E.B., Ph.D., Professor
Tapley, B.D., Ph.D., Professor and Chairman

DEPARTMENT OF CHEMICAL ENGINEERING

Wissler, E.H., Ph.D., Chairman and Professor

DEPARTMENT OF CIVIL ENGINEERING

Fruh, E.G., Ph.D., Associate Professor
Gloyna, E.F., Dr. of Engr., Dean, Professor, and Director, Center for Research in Water Resources
Jehn, K.H., M.S., Associate Professor and Director, Atmospheric Science
Malina, J.F., Ph.D., Professor and Director, Environmental Health Engineering Laboratories
Masch, F.D., Ph.D., Professor
Matlock, H., M.S., Professor
Moore, W.L., Ph.D., Professor
Reese, L.C., Ph.D., Chairman and Professor
Wagner, N.K., Ph.D., Associate Professor

DEPARTMENT OF ELECTRICAL ENGINEERING

Bostick, F.X., Ph.D., Professor
Gregg, W.D., Ph.D., Assistant Professor
Hixson, E.L.,Ph.D., Associate Professor
Smith, H.W., Ph.D., Professor
Straiton, A.W., Ph.D., Chairman and Professor

DEPARTMENT OF MECHANICAL ENGINEERING

Carter, W.J.,Ph.D., Professor
Gage, S.J., Ph.D., Associate Professor
Helfinstine, R.A., Ph.D., Assistant Professor

DEPARTMENT OF PETROLEUM ENGINEERING

Gray, K.E., Ph.D., Chairman and Professor
Jessen, F.W., Ph.D., Professor
Pirson, S.J., D.Sc., Professor

To obtain further information, address all inquiries directly to:

Dr. L.C. Reese, Chairman
Department of Civil Engineering
The University of Texas at Austin
Austin, Texas 78712

## UNITED STATES NAVAL ACADEMY
ANNAPOLIS, MARYLAND

The location of the Naval Academy, at the mouth of the Severn River on the Chesapeake Bay, provides an excellent environment for field studies in ocean systems engineering. A research vessel is available for individual or group research. This 65-ton, 84-foot vessel is completely instrumented for data collection and bathymetric surveying. In addition, the midshipmen are constructing an underwater habitat of their own design, which will be used as a field laboratory for the ocean engineering and oceanography programs. Laboratory and computer utilization play predominant roles in each of the engineering majors. A wide variety of modern laboratory equipment is available, including a sub-critical nuclear reactor and an 85-foot towing tank equipped with a pneumatic wave generator and on-line data aquisition and analysis equipment. Construction has begun on a new engineering laboratory complex which will include a 380-foot towing tank and a large, high-pressure ocean simulation chamber.

The B.S. in Marine Engineering, B.S. in Naval Architecture, B.S. in Ocean Engineering are offered. Each of these degrees is offered in the Department of Naval Systems Engineering. They are interdisciplinary fields involving the application of engineering principles to engineering systems in the ocean environment. Fundamentals of mathematics, physics, mechanical engineering, electrical engineering, and oceanography are presented, followed by a broad selection of engineering courses directly in the student's chosen major. In addition, each student must complete 24 semester hours of liberal arts courses (history, political science, economics, and literature) and a series of professional courses which include navigation, weapons systems, psychology, tactics, and international law.

The Marine Engineering Program places major emphasis on the principles of energy conversion and marine propulsion systems design and analysis for both nuclear and fossils plants. Each student is required to complete at least 30 semester hours of courses in the field of marine engineering which must include Oceanography SO-221, Physics SP-301, and Engineering EN-361, EN-362, EN-377, EN-460, EN-466, and EM-411.

The Naval Architecture Program encompasses a comprehensive analysis and design of vehicles that operate on, under, or just above the air-sea interface. The curriculum covers the static and dynamic analyses of ships, both theoretically and experimentally, as well as basic design techniques. The required 30 semester hours of courses in the field of naval architecture must include Oceanography SO-221 and Engineering EN-361, EN-351, EN-352, EN-377, EN-453, EN-455, and EN-460.

The Ocean Engineering Program provides the student with a fundamental introduction to the application of engineering in the undersea environment, with particular emphasis on structures, materials, wave mechanics, power, acoustics, and life-support systems. At least 31 semester hours are required in the field of ocean engineering, and must include Oceanography SO-221, Physics SP-411, and Engineering EN-361, EN-377, EN-375, EN-460, EN-473, and EN-477.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF NAVAL SYSTEMS ENGINEERING

| | | |
|---|---|---|
| EN-200 | Naval Engineering I | 4 |
| EN-361 | Principles of Ocean Systems Engineering | 4 |
| EN-301 | Naval Engineering II | 4 |
| EN-351 | Naval Architecture I | 3 |
| EN-352 | Naval Architecture II | 3 |
| EN-362 | Reactor Physics I | 3 |
| EN-372 | Engineering Properties of Marine Sediments | 2 |
| EN-373 | Life Support Systems | 3 |
| EN-377 | Ocean Systems Engineering Seminar | 1 |
| EN-375 | Ocean Engineering Materials and Structures | 4 |
| EN-376 | Coastal Engineering | 3 |
| EN-453 | Naval Architecture III | 3 |
| EN-455 | Ship Structure | 3 |
| EN-457 | Hydrofoil and Propeller Theory | 3 |
| EN-458 | Advanced Marine Vehicles | 3 |
| EN-460 | Ocean System Design | 3 |
| EN-463 | Reactor Physics II | 3 |
| EN-464 | Reactor Control Analysis | 3 |
| EN-465 | Advanced Reactor Theory | 3 |
| EN-466 | Analysis of Marine Propulsion Equipment | 3 |
| EN-467 | Design of Marine Power Plants | 3 |
| EN-472 | Design of Submersibles and Support Vessels | 3 |

| | | |
|---|---|---|
| EN-473 | Ocean Engineering Mechanics | 3 |
| EN-477 | Undersea Power Systems | 3 |
| EN-481 | Advanced Topic in Naval Engineering | 3 |
| EN-491-492 | Naval Engineering Research, Design or Construction Project | 1, 2, or 3 |
| EN-493-494 | Naval Engineering Research, Design or Construction Project | 1, 2, or 3 |
| EN-495-496 | Naval Engineering Research, Design or Construction Project | 1, 2, or 3 |

DEPARTMENT OF ENVIRONMENTAL SCIENCES

| | | |
|---|---|---|
| SO-221 | General Oceanography | 3 |

DEPARTMENT OF PHYSICS

| | | |
|---|---|---|
| SP-301 | Modern Physics | 3 |
| SP-411 | Underwater Acoustics and Sonar | 3 |

The Academy also offers an undergraduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF NAVAL SYSTEMS ENGINEERING

Barr, William A., M.S., Associate Professor
Bhattacharyya, Rameswar, Ph.D., Head of Naval Architecture and Assistant Professor
Billow, Leon M., M.E., Assistant Professor
Bissell, Allen M., M.E., Lieutenant Commander, USN
Bock, Arthur E., M.S., Professor
Breed, William L., M.S.E.E., Lieutenant Commander, USN
Bullock, Harold O., Jr., M.S., Lieutenant Commander, USN
Compton, Roger H., M.S., Assistant Professor
Davis, James V., M.S., Lieutenant Commander, USN
Duckett, Philip V.L., B.S., Commander, USN
Eckley, Wayne F., M.S., Associate Professor
Gentz, Richard C., M.S., Lieutenant Commander, USN
Huckenpoehler, William B., Jr., M.N.E., Assistant Professor
Johnson, Bruce, Ph.D., Professor
McCormick, Michael E., Ph.D., Chairman and Associate Professor
Monney, Neil T., Ph.D., Head of Ocean Engineering and Assistant Professor
Latham, Robert F., M.A., Associate Professor
Losure, John E., M.S., Associate Professor
McCormick, Michael E., Ph.D., Chairman and Associate Professor
Monney, Neil T., Ph.D., Head of Ocean Engineering and Assistant Professor
Morrissey, Jon E., M.S., Lieutenant Commander, USN
Rankin, Bruce H., Ph.D., Head of Marine Engineering and Professor
Remoll, Charles M., B.S., Lieutenant Commander, USN
Schulden, William H., M.N.E., Assistant Professor
Schmidt, Robert H., M.E., Commander, USN
Van Mater, Paul R., Jr., Ph.D., Associate Professor
Wiggins, Peter F., Ph.D., Associate Professor

To obtain further information, address all inquiries directly to:

Dean of Admissions
United States Naval Academy
Annapolis, Maryland 21402

## UNIVERSITY OF WASHINGTON
### SEATTLE, WASHINGTON

There are a number of laboratories throughout the College of Engineering which are used to support teaching and research in Ocean Engineering. A subsonic wind tunnel (8-foot by 12-foot section, 180 miles per hour) with an external air supply at a pressure of 3,000 psi with a mass flow of 1.5 pounds per second is operated in Aeronautics and Astronautics. A large Chemical Engineering Laboratory with special facilities such as a 20-foot glass distillation column, a 20-foot absorption column, and a fluid (air and water) loop for research and calibration is available. Laboratories for hydraulics, structures, materials, soil mechanics, water biology and chemistry are located in Civil Engineering. Those for acoustics, electronics and control systems, and energy conversion are in Electrical Engineering. Mechanical Engineering has laboratories of heat transfer and thermodynamics, experimental stress analyses, material processing, and vibrations and acoustics. A ceramics laboratory and those for material properties andmineral processing are available through Mining, Mettallurgy and Ceramics. Nuclear Engineering has a separate teaching and research nuclear reactor (100 KW argonaut type) housed in a separate facility. A bottom mounted, surface piercing instrument platform in Puget Sound operated by the Division of Marine Resources is also available. Outstanding collections of books and periodicals of interest to engineers as well as a research computer laboratory round out the facility.

Students may specialize in Ocean Engineering at the B.S., M.S., or Ph.D. level by enrolling through the College of Engineering at the undergraduate level and by enrolling through any of the engineering departments in the College of Engineering at the graduate level. Theses at the M.S. and Ph.D. level are required in the field of Ocean Engineering. The addition and substitution of courses in oceanography, fisheries, atmospheric sciences, economics, etc., into the engineering program are presently arranged on an individual basis. Degrees are granted through the College of Engineering with a major in the appropriate engineering field. Detailed information on the degree requirements may be obtained by reference to the University of Washington general catalog.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These in-

clude Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering, Mechanical Engineering, Oceanography, and Zoology. It also coordinates the Sea Grant Program which involves courses related to marine resources taught in various Departments and Colleges.

The following courses are offered in conjunction with the above programs (credits are in quarter hours). Basic engineering courses required for studies in Ocean Engineering from all the branches of engineering have not been listed. These may be obtained by reference to the University of Washington general catalog. In addition to the course offerings in engineering listed below and those listed in the other sections under the University of Washington's program in Oceanography and Fisheries, courses dealing with the ocean and other courses of use to marine scientists are offered in the departments of Botany, Geophysics, Atmospheric Sciences, Zoology, International Business, Geography, the College of Forest Resources, The Department of Economics, and the School of Law. (Courses numbered 500 and above are graduate courses.)

AERONAUTICS AND ASTRONAUTICS

| | | |
|---|---|---|
| 510 | Wave Propagation in Fluids and Solids | 3 |
| 567 | Analysis in Engineering | 3 |
| 568 | Analysis in Engineering | 3 |
| 600 | Independent Study or Research | |
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

CHEMICAL ENGINEERING

| | | |
|---|---|---|
| 600 | Independent Study or Research | |
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

CIVIL ENGINEERING

| | | |
|---|---|---|
| 350 | Environmental Engineering | 4 |
| 390 | Environmental Systems Planning | 4 |
| 421 | Transportation Engineering | 3 |
| 441 | Intermediate Fluid Mechanics | 3 |
| 450 | Man and Pollution of His Environment | 3 |
| 452 | Systems Engineering Fundamentals | 3 |
| 455 | Water Biology | 4 |
| 457 | Instrumentation for Water and Air Analysis | 3 |
| 498 | Special Topics: Hydraulics | 1-5 |
| 498 | Special Topics: Water and Air Resources | 1-5 |
| 520A | Structural Safety | 1 |
| 522 | Transportation Systems | 3 |
| 523 | Transportation Terminals | 3 |
| 542 | Hydrodynamics I | 3 |
| 543 | Hydrodynamics II | 3 |
| 544 | Coastal Hydraulics | 3 |
| 549 | Experimental Hydrodynamics | 3 |
| 550 | Sanitary Engineering Unit Operations I | 3 |
| 551 | Sanitary Engineering Unit Operations II | 3 |
| 553 | Advanced Water Biology | 4 |
| 556 | Bioengineering Aspects of Waste Treatment | 3 |
| 557 | Water and Waste-Water Treatment | 3 |
| 558 | Water Quality Management | 3 |
| 559 | Water Resource Management | 3 |
| 573 | Structural Mechanics I | 3 |
| 574 | Structural Mechanics II | 3 |
| 575 | Structural Mechanics III | 3 |
| 593 | Marine Technology Affairs | 2 |
| 600 | Independent Study or Research | |
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

ELECTRICAL ENGINEERING

| | | |
|---|---|---|
| 421 | Electroacoustics | 4 |
| 505 | Analysis of Random Processes | 4 |
| 525 | Acoustics in Engineering | 3 |
| 526 | Acoustics in Engineering | 3 |
| 595 | Marine Acoustics, Signal Processing of Acoustics Signals | 3 |
| 600 | Independent Study or Research | |
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

MECHANICAL ENGINEERING

| | | |
|---|---|---|
| 406 | Corrosion and Surface Treatment Materials | 3 |
| 473 | Instrumentation | 3 |
| 490 | Naval Architecture | 3 |
| 491 | Naval Architecture | 3 |
| 492 | Naval Architecture | 3 |
| 525 | Acoustics in Engineering | 3 |
| 526 | Acoustics in Engineering | 3 |
| 600 | Independent Study or Research | |
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

MINING, METALLURGICAL, AND CERAMIC ENGINEERING

| | | |
|---|---|---|
| 351 | Mineral Processing I | 4 |
| 352 | Mineral Processing II | 2 |
| 423 | Corrosion of Engineering Materials | 3 |
| 426 | Exploration and Development of Mineral Deposits | 4 |
| 427 | Exploration Geophysics: Introduction | 3 |
| 472 | Mineral Processing Practices | 3 |
| 571 | Advanced Mineral Processing Theory I | 3 |
| 573 | Advanced Mineral Processing Theory II | 3 |
| 600 | Independent Study or Research | |
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

NUCLEAR ENGINEERING

| | | |
|---|---|---|
| 700 | Thesis | |
| 800 | Doctoral Dissertation | |

OCEAN ENGINEERING

| | | |
|---|---|---|
| 551 | Ocean Engineering Systems Design I | 3 |
| 552 | Ocean Engineering Systems Design II | 3 |

The University also offers undergraduate and graduate programs in marine sciences and fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Bollard, R. J. H., Ph.D., Professor and Chairman
Fyfe, Ian F., Ph.D., Professor of Aeronautics
Vagners, Juris, Ph.D., Assistant Professor of Aeronautics and Astronautics

DEPARTMENT OF CHEMICAL ENGINEERING

Gardner, Howard S., Sc.D., Professor of Chemical Engineering and of Pulp and Paper Technology
Moulton, R. Wells, Ph.D., Professor and Chairman of Chemical Engineering

DEPARTMENT OF CIVIL ENGINEERING

Carlson, Dale A., Ph.D., Professor of Civil Engineering
Christman, Russell F., Ph.D., Associate Professor of Chemistry
Hartz, Billy J., Ph.D., Professor of Civil Engineering
Hennes, Robert G., M.S., Professor and Chairman
Mar, Brian W., Ph.D., Research Associate Professor of Civil Engineering
Nece, Ronald E., Sc.D., Professor of Civil Engineering
Richey, Eugene P., Ph.D., Professor of Civil Engineering
Sherif, Mehmet A., Ph.D., Associate Professor of Civil Engineering
Sylvester, Robert O., S.M., Professor of Civil Engineering
Welch, Eugene B., Ph.D., Associate Professor of Applied Biology
Wenk, Edward, Ph.D., Professor of Engineering and Public Affairs

DEPARTMENT OF ELECTRICAL ENGINEERING

Clark, Robert N., Ph.D., Professor of Electrical Engineering
Dow, Daniel G., Ph.D., Professor and Chairman of Electrical Engineering
Lytle, Dean W., Ph.D., Professor of Electrical Engineering
Rogers, Walter E., M.S., Professor of Electrical Engineering
Sigelmann, Rubens A., Ph.D., Associate Professor of Electrical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Adee, Bruce, Ph.D., Assistant Professor of Mechanical Engineering
Galle, Kurt R., Ph.D., Associate Professor of Mechanical Engineering
Jorgensen, Jens E., Sc.D., Assistant Professor of Mechanical Engineering
Kippenhan, Charles J., Ph.D., Professor and Chairman of Mechanical Engineering
Merchant, Howard C., Ph.D., Associate Professor of Mechanical Engineering
Murphy, Stanley R., Ph.D., Professor of Oceanography and Mechanical and Ocean Engineering
Sandwith, Colin, Ph.D., Assistant Professor of Mechanical Engineering
Vesper, Karl H., Ph.D., Associate Professor of Management and Organization and Mechanical Engineering

DEPARTMENT OF MINING, METALLURGICAL AND CERAMIC ENGINEERING

Brien, Frederick B., M.S., Professor of Mineral Engineering
Polonis, Douglas H., Ph.D., Professor and Chairman of Mining, Metallurgical and Ceramic Engineering
Zupp, Richard R., Ph.D., Assistant Professor of Metallurgical Engineering

DEPARTMENT OF NUCLEAR ENGINEERING

Babb, Albert L., Ph.D., Professor and Chairman of Nuclear Engineering,
Director, Nuclear Reactor Laboratories
Woodruff, Gene L., Ph.D., Associate Professor of Nuclear Engineering, Associate Director, Nuclear Reactor Laboratories

To obtain further information, address all inquiries directly to:

Professor Eugene P. Richey
313 Harris Hydraulics Laboratory WD-10
University of Washington
Seattle, Washington 98105

## WEBB INSTITUTE OF NAVAL ARCHITECTURE
GLEN COVE, NEW YORK

The college offers a course of study in naval architecture and marine engineering to train and educate young men who are interested in the design and construction of ships.

Specialized facilities include a 93 x 10 x 5-foot model basin with wave maker, a flow channel, a marine engineering laboratory which includes operating components of commonly encountered marine machinery, and a time-sharing computer laboratory.

The Bachelor of Science in Naval Architecture and Marine Engineering is offered by the Institute.

The following courses are offered in conjunction with the above program:

Practical Naval Architecture I
Practical Naval Architecture II
Ship Resistance and Propellers I
Ship Resistance and Propellers II
Theoretical Naval Architecture I
Theoretical Naval Architecture II
Theoretical Naval Architecture III
Theory of Structures
Ship Structures
Ship Design I & II
Marine Engineering I
Marine Engineering II
Marine Engineering III
Marine Engineering IV
Marine Engineering V
Marine Engineering VI
Hydrodynamics

The instructional staff for the courses listed above consists of the following:

Hamlin, Norman A., S.M., Research Professor of Naval Architecture
Hoffman, Dan, B.Sc., Research Associate
Holm, Jens T., M.S., Professor of Marine Engineering
Lewis, Edward V., M.S., Research Professor of Naval Architecture
Maclean, Walter M., D.Eng., Professor of Engineering
Nevitt, Cedric R., S.M., Professor of Naval Architecture

To obtain further information, address all inquiries directly to:

W.A. Brockett, Rear Admiral, USN (Ret.)
President
Webb Institute of Naval Architecture
Glen Cove, New York 11542

## UNIVERSITY OF WISCONSIN
### MADISON, WISCONSIN

(For a complete description of the University's facilities, see the listing in the Marine Sciences section of this publication.)

The following degrees are offered:

1. M.S. in Ocean Engineering.
2. Ph.D. with option in Ocean Engineering.

The Ocean Engineering program is designed to provide engineers a thorough background in the unique problems associated with working at sea. The program will give engineering students a formal method of entering the field of oceanography, while using their technical talents.

The M.S. in Ocean Engineering, which should be available in 1971, will be administered by the Ocean Engineering Committee, and will be constructed around a core of ocean-oriented courses: CE 661, 662, 665, 669. Students must take either 24 semester credits, including a thesis, or 30 credits without a thesis. Some field experience will be required.

The Ph.D. program is more loosely organized. A student remains in one of the "traditional" engineering departments, works on a dissertation associated with ocean engineering, and usually minors in oceanography and limnology.

Students in these programs may select any graduate course in the University. The following courses are offered in conjunction with the above programs:

DEPARTMENT OF CIVIL ENGINEERING

| | | |
|---|---|---|
| 406 | Remote Sensing of the Environment | 3 |
| 602 | Hydrodynamics | 3 |
| 612 | Open Channel Hydraulics | 3 |
| 621 | Hydrology | 3 |
| 622 | Water Resources Engineering | 3 |
| 661 | Ocean Dynamics | 2 |
| 662 | Dynamical Oceanography | 2 |
| 664 | Technology of Ocean Operations | 3 |
| 665 | Ocean Environment | 3 |
| 669 | Ocean Engineering Seminar | 1 |
| 676 | Diffusion and Dispersion | 3 |
| 863 | Free Surface Flow (Water waves) | 3 |
| 960 | Hydraulic Engineering and Fluid Mechanics Seminar | 1 |

The University also offers a graduate program in Oceanography and Limnology which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF CIVIL ENGINEERING

Clapp, James L., Ph.D., Associate Professor of Civil Engineering
Green, Theodore, (See Meteorology)
Hoopes, John A., Ph.D., Associate Professor of Civil Engineering
Huff, Dale D., Ph.D., Assistant Professor of Civil Engineering
Lenz, Arno T., Ph.D., Professor of Civil Engineering
Lettau, Heinz H., (See Meteorology)
Monkmeyer, Peter L., Ph.D., Professor of Civil Engineering
Rohlich, Gerard A., Ph.D., Professor of Civil Engineering
Saul, William E., Ph.D., Associate Professor of Civil Engineering
Villemonte, James R., Ph.D., Professor of Civil Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Harker, Ralph J., M.S., Professor of Mechanical Engineering
Livermore, Donald F., Ph.D., Professor of Mechanical Engineering
Seirig, Ali A., Ph.D., Professor of Mechanical Engineering

DEPARTMENT OF NUCLEAR ENGINEERING

Huston, Norman E., Ph.D., Professor of Nuclear Engineering

DEPARTMENT OF ENGINEERING MECHANICS

Huang, T. C., Ph.D., Professor of Engineering Mechanics

To obtain further information, address all inquiries directly to:

Professor Robert A. Ragotzkie
University of Wisconsin
1225 West Dayton Street
Madison, Wisconsin 53706

## WOODS HOLE OCEANOGRAPHIC INSTITUTION
### WOODS HOLE, MASSACHUSETTS

(For a description of the facilities at Woods Hole Oceanographic Institute, please refer to the Institute's listing in the Marine Sciences section of this publication.)

Massachusetts Institute of Technology and Woods Hole have undertaken a joint graduate degree program in ocean engineering leading to the award of the degree of Doctor of Philosophy or to the professional degree. The program of study and research will concentrate on those areas of ocean engineering required for the advancement of the ocean sciences. The goal of the Joint Program in Ocean Engineering education is to lay the foundation for a career in oceanography with a specialty in ocean engineering or alternatively a career in engineering with a specialty in oceanographic engineering.

Students are first admitted to graduate studies at Massachusetts Institute of Technology, and then, if interested, considered for admission to the Joint Program in Ocean Engineering.

The following degrees are offered:

1. Ocean Engineer - (professional degree) offered jointly by Woods Hole Oceanographic Institution and Massachusetts Institute of Technology. The requirements for the degree of Ocean Engineer (professional degree) shall include the satisfactory completion of a core curriculum, achievement of the appropriate distribution and credit requirements and the submission of a satisfactory thesis. Two full years of graduate study will usually be required to achieve the professional degree. The new student will be encouraged to spend his first summer at Woods Hole taking an introductory graduate course involving considerable field and laboratory experience. The first academic year will normally be spent at Massachusetts Institute of Technology in pursuit of the more fundamental graduate courses and the second summer and academic year will be spent at Woods Hole in the pursuit of courses and seminars associated with the fields of interest of the Woods

Hole Oceanographic Institution, including those in the scientific disciplines and engineering systems.

2. Ph.D. in Ocean Engineering offered jointly by Woods Hole Oceanographic Institution and Massachusetts Institute of Technology. The Doctor of Philosophy degree usually requires a minimum of three years of graduate study and encompasses the satisfactory completion of a comprehensive core curriculum, the passage of a qualifying examination, the meeting of language requirements, independent research in a topic with related additional course work, the reporting of this research in a dissertation and the oral defense of this dissertation.

The academic program at Woods Hole in ocean engineering is a year-round activity. During the summer a program of study in oceanographic systems (13.990 and 13.991) is offered. Students entering the program are urged to attend as are students completing their first year at Massachusetts Institute of Technology and entering upon the Woods Hole phase of of their course.

During the fall term of the second academic year, engineering students at Woods Hole will be expected to carry a course load of two engineering systems subjects and at least two science subjects. During the spring term students will be expected again to take two subjects in the field of oceanographic engineering and one subject in the science of oceanography. Professional degree candidates will conduct their research and commence their thesis during this term. Ph.D. candidates will normally take their qualifying examinations at the end of this term and commence their research and thesis at the beginning of the next.

The following courses are offered in conjunction with the above programs:

M.I.T.

| | |
|---|---|
| 13.990 | Oceanographic Systems I |
| 13.991 | Oceanographic Systems II |
| 13.992 | Oceanographic Systems Analysis I |
| 13.993 | Oceanographic Systems Analysis II |
| 13.994 | Buoy Engineering |
| 13.995 | Oceanographic Deep Submergence Engineering (A) |

The Woods Hole Oceanographic Institution also offers Ph.D. degree programs in oceanography jointly with Massachusetts Institute of Technology and independently, which are described in the section on marine sciences. Please refer to this section, as well as the Massachusetts Institute of Technology section in ocean engineering for additional course offerings.

The instructional staff for the courses listed above consists of the following:

Daubin, Scott C., Ph.D., Engineer/Physicist and Senior Scientist
Berteaux, Henri O., M.S., Engineering Physics and Research Associate
Mavor, James W., S.M., Mechanical Engineer and Research Specialist
Williams, Albert, Ph.D., Physicist and Postdoctoral Investigator

To obtain further information, address all inquiries directly to:

Dr. H. Burr Steinbach
Dean of Graduate Studies
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

# *CURRICULA IN*

# *FISHERIES*

## UNIVERSITY OF CALIFORNIA, DAVIS
### DAVIS, CALIFORNIA

The Institute of Marine Resources was recently transferred from the Berkeley campus to Davis. A new temporary building has been built to house the offices and laboratories of the Marine Food Science Laboratory. The Laboratory is primarily a research facility and is equipped to study the chemistry and biochemistry of marine organisms as they may be useful as sources of food.

The following degrees are offered:

1. M.S. in Food Science (Food Science and Technology).
2. M.S., Ph.D. in Nutrition (Group Major).
3. B.S. in Wildlife and Fisheries Biology (Group Major sponsored by Animal Physiology).

The following courses are offered in conjunction with the above programs:

WILDLIFE AND FISHERIES BIOLOGY

| | | |
|---|---|---|
| 130 | Biology of Fish | 5 |
| 110B | Principles of Fish Managment | 3 |
| 101 | Field Studies in Wildlife and Fish Management | 5 |

These courses are augmented by the extensive course offerings of the Department of Zoology which are described in the Marine Sciences section of this publication.

The University also offers undergraduate and graduate programs in Geology and Zoology and graduate programs in Ecology and Biochemistry which are described in the Marine Sciences section of this publication.

The instructional staff for the courses listed above consists of the following:

FOOD SCIENCE AND TECHNOLOGY

Brown, W. D., Ph.D., Professor of Marine Food Science
Olcott, H. S., Ph.D., Professor of Marine Food Science

ANIMAL PHYSIOLOGY

Brocksen, R. W., Ph.D., Assistant Professor
Calhoun, A. J., Ph.D., Lecturer

To obtain further information, address all inquiries directly to:

MARINE FOOD SCIENCES

H. S. Olcott
Institute of Marine Resources
University of California
Davis, California 95616

WILDLIFE AND FISHERIES BIOLOGY

J. M. Boda
Animal Physiology
University of California
Davis, California 95616

## HUMBOLDT STATE COLLEGE
### ARCATA, CALIFORNIA

The marine sciences programs at Humboldt State College offer instruction and opportinities for research in marine fisheries, oceanography, and the marine aspects of zoology, botany, and ecology. Present facilities include recirculating freshwater fish hatchery and auxiliary facilities, saltwater aqaria, a water chemistry laboratory, ichthyology laboratories, and zoology and botany classrooms and laboratories. Research vessels equipped with standard oceanographic and biological instrumentation are available. A marine sciences laboratory with a modern saltwater system is located at Trinidad, California. Equipment, technical guidance, and financial aid are provided graduate students and some seniors through programs on marine sport fisheries conducted by the California Cooperative Fisheries Unit.

The College offers the following degrees through the School indicated:

SCHOOL OF NATURAL RESOURCES

1. Bachelor of Science in Fisheries

a. General Education - Required and elective courses to insure cultural breadth in the humanities, social sciences and English and speech.

b. Lower division requirements: Biol. 3; Bot. 1; Chem. 10A-10B, 11; Math 15A; Nat. Res. 2, 40; Zool. 1; Physics 15A-15B.

c. Upper division requirements: Zool. 112; one course from the following upper division physiology offerings; Zool. 101, 143; Biol. 100; Bot. 101; one course from the following upper division botany offerings: Bot. 111, 140, 145; Fish. 110A-110B-110C; Fish. 120A-120B; or Ocn. 100; Fish. 130 or 135, Fish. 150, Fish. 160, Fish 195, and Fish. 198.

d. Approved electives: A total of 25 units.

e. Free electives to bring total units for the B.S. degree to 192.

2. Master of Science in Fisheries

a. Prerequisites: Satisfactory undergraduate preparation in fisheries or zoology.

b. Required courses: Fisheries 260, 290,295, and 298.

c. Approved upper division or graduate electives in related fields to bring total units beyond the bachelor's degree to 45. Thesis required.

The following courses are offered in conjunction with the above programs: (Credits are in quarter hours).

SCHOOL OF NATURAL RESOURCES

FISHERIES COURSES

UPPER DIVISION UNDERGRADUATE COURSES

| | | |
|---|---|---|
| 100 | Introduction to Fishery Biology | 3 |
| 102 | Field Course in Fishery Biology | 3 |
| 110A | Ichthyology (classification) | 4 |
| 110B | Ichthyology (Anatomy) | 3 |
| 110C | Ichthyology (Physiology) | 3 |
| 120A | Physical Limnology | 3 |
| 120B | Biological Limnology | 3 |
| 130 | Ecology Freshwater Fishes | 4 |
| 135 | Ecology of Marine Fishes | 4 |
| 143 | Problems in Water Pollution Biology | 3 |
| 150 | Introductory Fish Population Dynamics | 3 |
| 160 | Principles of Fishery Management | 3 |
| 170 | Fish Culture and Breeding | 3 |
| 175 | Commercial Fisheries | 3 |
| 180 | Techniques in Fishery Biology | 3 |

| | | |
|---|---|---|
| 184 | Fisheries Instrumentation, Gear, and Methods | 2 |
| 195 | Field Problems in Fisheries | 1-4 |
| 196 | Field Trip | 1-4 |
| 198 | Senior Fisheries Seminar | 1 |

GRADUATE COURSES

| | | |
|---|---|---|
| 240 | Early Life History of Fishes | 3 |
| 245 | Economically Important Invertebrates | 3 |
| 250 | Advanced Fish Population Dynamics | 3 |
| 260 | Advanced Principles of Fisheries Management | 4 |
| 290 | Thesis | 1-4 |
| 295 | Research Problems in Fisheries | 1-4 |
| 298 | Graduate Fisheries Seminar | 1 |

The College also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

SCHOOL OF NATURAL RESOURCES

Allen, George H., Ph.D., Professor and Program Leader of Fisheries
Barnhart, Roger A., Ph.D., Adjunct Associate Professor and Unit Leader, California Cooperative Fishery Unit
Bryant, Charles F., Ph.D., Adjunct Assistant Professor and Assistant Unit Leader, California Cooperative Fishery Unit
DeWitt, John Jr., Ph.D., Professor of Fisheries
Roelofs, Terry D., Ph.D., Assistant Professor of Fisheries
Welsh, James P., Ph.D., Associate Professor of Fisheries

To obtain further information, address all inquiries directly to:

Dr. George H. Allen
Program Leader, Fisheries
Humboldt State College
Arcata, California 95521

## LOUISIANA STATE UNIVERSITY
BATON ROUGE, LOUISIANA

The School of Forestry and Wildlife Management has three laboratories on the LSU campus available for marine and marine-related research in the field of fisheries. The School also has access to various facilities of the Louisiana Wild Life and Fisheries Commission. Most notable is the marine lab at Grand Terre, La. and the Rockefeller Wildlife Refuge at Grand Chenier, La. At Grand Terre the facility has been used to study the effects of oil pollution on shrimp. At Rockefeller, cooperative research on mariculture is being conducted in some 60 ponds.

The School offers a Master of Science with a major in fisheries. Fishery courses required for the M.S. include: Fundamentals of Fish Culture, Ichthyology, Limnology, and Fishery Research Techniques. Courses may be substituted for required courses, depending on the students' needs and research. Requirements for the M.S. degree include 30 semester hours of graduate work, including six semester hours of thesis research. There are no language requirements, and a minor is optional.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| 121 | Ichthyology | 3 |
| 123 | Taxonomy and Ecology of Aquatic Plants | 2 |
| 125 | Limnology | 3 |
| 126 | Fundementals of Fish Culture | 3 |
| 230 | Fish Parasites and Diseases | 2 |
| 232 | Fishery Research Techniques | 2 |
| 236 | Water Pollution Biology | 3 |
| 238 | Fisheries Hydrography | 3 |
| 239 | Shellfisheries Biology | 3 |
| 240 | Mariculture | 3 |

The University also offers graduate programs in marine science and ocean law which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Avault, James W., Jr., Ph.D., Associate Professor of Fisheries
de la Bretonne, Laurence, W., Jr., M.S., Instructor of Fisheries
Culley, Dudley, D., Jr., Ph.D., Assistant Professor of Fisheries
Truesdale, Frank M., Ph.D., Assistant Professor of Fisheries

COOPERATIVE FISHERIES UNIT

Herke, William H., M.S., Assistant Unit Leader
Tash, Jerry C., Ph.D., Unit Leader

To obtain further information, address all inquiries directly to:

Dr. Paul Y. Burns, Director
School of Forestry and Wildlife Management
Louisiana State University
Baton Rouge, Louisiana 70803

## UNIVERSITY OF MASSACHUSETTS
AMHERST, MASSACHUSETTS

(For a description of the facilities and the marine science and ocean engineering programs at the University of Massachusetts, please refer to the University's listing in the appropriate sections of this publication.)

The University offers the following degrees:

1. Master of Science in Marine Sciences. Students seeking this degree should have a science background including chemistry, physics and introductory calculus in addition to a major in one of the basic or applied sciences. This degree program is intended to prepare students for further graduate work or for employment in marine-related government or industrial positions. Some students with exceptional liberal arts backgrounds may use this degree for training in a new field.

Students are admitted to the Graduate School via the interdisciplinary Marine Sciences Program (equal to a graduate department) with the approval of the department of the student's chosen specialty option. Students are required to take a broad oceanographic core curriculum of three courses:

Physical Oceanography, (Geology 655), Geological Oceanography (Geology 752) and Biological Oceanography (Marine Sciences 501). Fifteen credits will be required in the chosen specialty option: fisheries or food science and technology. A student will demonstrate oceanographic research abilities through the completion of either a six to eight hour special problem or a thesis. Shipboard experience on board R/V EASTWARD (Marine Sciences 700) or its equivalent is strongly recommended. A student must pass a comprehensive written examination upon the core curriculum content and a qualifying examination if required by the department of his specialty option; he will not, however, be expected to demonstrate the breadth of the normal departmental major in the specialty. Option courses are arranged with consent between the Program and the Department. At least six hours of 700-900 level courses are required. Language examinations requirements follow those of the department of the option.

2. Doctor of Philosophy in Fisheries Biology and Food Science and Technology. As yet there is no doctoral program in oceanography at the University but students may be admitted into the regular doctoral programs of the various departments participating in the Marine Sciences Program and receive a marine-oriented doctoral degree. Many faculty in each of these departments are currently involved in marine research and in graduate eduction. Guidance committees are often composed of faculty crossing departmental lines which permits flexibility in the preparation of these students. Language requirements and course requirements vary between departments and specific requirements can be obtained by consulting the current Graduate School Bulletin.

The following courses are offered in conjunction with the above programs:

FISHERIES BIOLOGY

| | | |
|---|---|---|
| 565 | Techniques of Fisheries Biology | 3 |
| 567 | Laboratory in Techniques of Fishery Biology | 1 |
| 570 | Ecology of Fishes | 3 |
| 572 | Introduction to Marine Fisheries | 3 |
| 700 | Special Problems in Fisheries Biology | 3 |
| 701 | Seminar in Fisheries Biology | 1-3 |
| 702 | Seminar in Fisheries Biology | 1-3 |
| 756 | Fisheries Biometrics | 3 |
| 757 | Advanced Fisheries Management | 3 |

FOOD TECHNOLOGY

| | | |
|---|---|---|
| 575 | Survey of Food Technology | 3 |
| 661 | Principles of Food Technology | 3 |
| 662 | Advanced Food Technology | 3 |
| 671 | Analysis of Food Products | 3 |
| 684 | Sensory Evaluation Methods | 2 |
| 809 | Microbiology and Food Processing | 3 |
| 810 | Thermobacteriology and Food Processing | 3 |
| 821 | Lipid Chemistry | 3 |
| 841 | Advanced Food Analysis | 3 |
| 850 | Colorimetry and Appearance | 2-3 |

The University also offers graduate programs in Marine Science and Ocean Engineering which are described in the appropriate section of this publication.

The instructional staff for the courses listed above consists of the following:

FISHERIES BIOLOGY SECTION;
FORESTRY AND WILDLIFE MANAGEMENT DEPARTMENT

Cole, Charles F., Ph.D., Associate Professor of Fisheries Biology, Assistant Chairman, Marine Sciences Council
Johnson, James E., Ph.D., Assistant Professor of Fisheries Biology
McCann, James A., Ph.D., Associate Professor of Fisheries Biology
Reed, Roger J., Ph.D., Associate Professor of Fisheries Biology

FOOD SCIENCES

Clydesdale, Fergus M., Ph.D., Assistant Professor of Food Science and Technology
Esselen, William, B., Ph.D., Head of Department, Professor of Food Science and Technology
Fagerson, Irving S., Ph.D., Professor of Food Science and Technology
Francis, Frederich J., Ph.D., Nicolas Appert Professor of Food Sciences and Technology
Hunting, Ward M., Ph.D., Assistant Professor of Food Science and Technology
Levin, Robert E., Ph.D., Assistant Professor of Food Science and Technology
Mulvaney, Thomas R., Ph.D., Associate Professor of Food Science and Technology
Nawar, Wassef W., Ph.D., Associate Professor of Food Science and Technology
Sawyer, F. Miles, Ph.D., Associate Professor of Food Science and Technology
Stumbo, Charles R., Ph.D., Professor of Food Science and Technology

To obtain further information, address all inquiries directly to:

Chairman, Marine Sciences Program
Munson Hall
University of Massachusetts
Amherst, Massachusetts 01002

## UNIVERSITY OF MIAMI
### CORAL GABLES, FLORIDA

(For a description of the facilities at the University of Miami, please refer to the University's listing in the Marine Sciences section of this publication.)

The following degrees are offered by the University:

1. M.S. degree in Fishery Science. All students are required to complete 30 credits and a thesis representing original research or critical review of literature on a topic approved by the staff. In most cases an examination demonstrating the reading knowledge of a foreign language (French, German, or Russian) and a comprehensive examination covering a general understanding of the major field as well as courses taken is required.

2. Ph.D. degree in Fishery Science. All students are required to obtain permission from their advisory committee and petition

the Academic Faculty of the School to enter the Ph.D. program. The student must spend at least two consecutive semesters beyond the first year's graduate work in full-time study at the University of Miami's School of Marine and Atmospheric Science.

At least 36 graduate credits in courses and seminar are required (these may include courses taken for the M.S. Degree, excluding thesis credits), plus 24 credits for the Dissertation. Up to 12 credits may be transferred from other insititutions if approved. In most cases a reading knowledge of two languages and a qualifying examination is required.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| FIS 500 | Fishery Biology | 3 |
| FIS 501 | Fishery Biology Laboratory | 1 |
| FIS 502 | Fishery Technology | 2 |
| FIS 521 | Saltwater Pollution Technology | 3 |
| FIS 581 | Supervised Projects | 2 |
| FIS 582 | Supervised Projects | 2 |
| FIS 602 | Fishery Seminar | 1 |
| FIS 603 | Fish Stocks and their Management | 3 |
| FIS 604 | Fish Stocks and their Management Laboratory | 1 |
| FIS 605 | Population Enumeration and Dynamics | 3 |
| FIS 606 | Ecology of Marine Parasites | 4 |
| FIS 607 | Biometrics in Marine Sciences | 4 |
| FIS 671 | Advanced Study in Fishery Science | 2 |
| FIS 679 | Advanced Study in Fishery Science | 2 |
| FIS 681 | Fishery Research | 2 |
| FIS 682 | Fishery Research | 2 |

The University also offers graduate programs in Marine Science, Ocean Engineering, and Ocean Law which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DIVISION OF FISHERY SCIENCES

Caillouet, Charles, Ph.D., Associate Professor
Idyll, Clarence P., Ph.D., Chairman and Professor
Iversen, Edwin, Ph.D., Associate Professor
Roessler, Martin, Ph.D., Assistant Professor
Runnels, Jonnie, Ph.D., Assistant Professor
Tabb, Durbin, Ph.D., Associate Professor
Ward, Benjamin, Ph.D., Associate Professor

To obtain further information, address all inquiries directly to:

Dr. Robert J. Hurley
Associate Dean for Graduate Studies
School of Marine and Atmospheric Science
University of Miami
10 Rickenbacker Causeway
Miami, Florida 33149

## OREGON STATE UNIVERSITY
CORVALLIS, OREGON

The Department of Fisheries and Wildlife is headquartered in the Bioscience Building on the Corvallis campus of Oregon State University. Construction of the Bioscience Building was completed in June, 1970, and it contains 66,304 net square feet of space for use by the department. Facilities include lecture rooms, teaching and research laboratories, constant temperature rooms, self-learning center, walk-in freezer, shop, ichthyological museum, radiation laboratory, offices for staff and graduate students and numerous supporting facilities.

Research into all aspects of fisheries are carried out at the following facilities which are not located on the Corvallis campus: Brooklane Laboratory, Fairplay Laboratory, Netarts Bay Laboratory, Port Orford Laboratory, Soap Creek Experimental Ponds, Western Kraft Experimental streams, Berry Creek Experimental Stream, Oak Creek Laboratory, Averill Fisheries Laboratory, and Pacific Fisheries Laboratory.

The Department of Food Science and Technology is housed in two modern buildings on the Corvallis campus. These buildings contain 78,000 square feet of office, teaching and research laboratory, and pilot plant space. The facilities are designed and well-equipped to carry out teaching and research activities peculiar to most areas in the food field.

A newly constructed Seafoods Laboratory is located at Astoria, Oregon on the Columbia-Youngs River estuary. The research center at Astoria has been operated as an integral part of the Department since 1940. The facility provides 7,000 square feet of laboratory and office space and serves as a center for marine food science research.

Adjacent to the central University campus, the Department operates the Food Toxicology and Nutrition Laboratory. This laboratory is especially designed for studies of toxicity, nutrition and carcinogenesis in fish. Its 5,500 square feet of laboratory and office space includes a complete histopathological laboratory and 140 separate fish rearing tanks abundantly supplied with a constant temperature water supply.

Food science and technology is the application of the sciences and engineering to the manufacture, preservation, storage, transportation, and consumer use of food products. The food science program is concerned with the science and research involving the chemical, physical, biological, microbiological, toxicological, and nutritive properties of foods.

The following degrees are offered by the indicated departments:

1. M.S. in Fisheries Science (Department of Fisheries and Wildlife). All students must complete a program of study totaling not less than 45 term hours including thesis (6-9 term hours) and courses approved for graduate credit. Approximately two-thirds of the work (30 term hours) must be in the major and one-third (15 term hours) in the minor. A residence of one academic year or fair equivalent is required. There is no foreign language requirement for the M.S. degree.

2. Ph.D. in Fisheries Science (Department of Fisheries and Wildlife). The Ph.D. degree is granted primarily for attainments and proved ability. There is no rigid credit requirement; however, the equivalent of at least three years full-time graduate work beyond the bachelor's degree is required. At least one academic year must be spent in continuous residence at O. S. U. with a minimum of 36 hours of graduate work. The foreign language requirement is deter-

mined by the student's doctoral committee subject to approval by the major department and the Dean of the Graduate School. A comprehensive preliminary examination is required for admission to candidacy for the Ph.D. degree. Every candidate must submit a thesis embodying the results of research, and giving evidence of originality and ability in independent investigation (usually 30-45 term hours). The thesis must be a real contribution to knowledge, based on the candidates own investigation, and be written in creditable literary form. All candidates must pass a final examination, part of which must be oral.

3. B.S. in Food Science and Technology (Department of Food Science and Technology). The undergraduate four-year program leads to the Bachelor of Science degree in Food Science and Technology under the agricultural science option, and educates the student in respect to all principle food commodity groups and all technologies used in processing them commercially. The minimum course requirements consist of the following:

| | |
|---|---|
| Food Science and Technology | 38 |
| Communications | 18 |
| Humanities and Social Sciences | 18 |
| Biological and Physical Sciences | 54 |
| Physical Education | 6 |
| Electives | 40 |
| Total term hours (minimum) | 174 |

4. M.S. in Food Science (Department of Food Science and Technology). Students must complete a program of study totaling not less than 45 term hours including thesis and courses approved for graduate credit. Approximately two-thirds of the work (30 term hours) must be in the major or be composed of courses approved by the major Department in the basic sciences and one-third (15 term hours) in the minor. Three credit hours of Seminar are recommended with Thesis representing 9 to 12 hours of major credit which must be the result of the student's independent research and preparation. No qualifying examination is required for the M.S. degree. A final oral examination of not less than two hours is required for presentation of the student's thesis and examination of his thesis and field of study.

5. Ph.D. in Food Science (Department of Food Science and Technology). The degree of Ph.D. is granted primarily for attainments and proved ability and prepares the student for research in a specialized field of study. A M.S. degree of equivalent (as evaluated by the graduate faculty of the Department) is required for a student who intends to work toward a Ph.D. degree. The student and his major professor formulate the Ph.D. study program. The Ph.D. program usually consists of 75 to 85 term hours beyond that required for a M.S. degree and is composed of approximately two-thirds formal course work and one-third thesis research. Minor fields of basic and applied science are recommended to support the major courses and the area of thesis research. Ph.D. programs are approved by the Department Head and the student's doctoral committee. A minimum of 6 term hours of seminar is required.

For the Ph.D. degree the student's doctoral committee determines on the basis of the student's needs and the foreign language scientific literature in his field of specialization, if two, one or no foreign language will be required or permitted. If no foreign language requirement is recommended by the student's doctoral committee, the foreign language requirement will be satisfied by (1) the taking of a course or courses (undergraduate or graduate) which are in subjects not usually included for credit in the major or minor, and which will have as their purpose the broadening of the student or provide a "tool" of particular value, and/or (2) a special project, other than laboratory research, which would distinctly benefit the student.

Written and oral preliminary examinations are required. A thesis which is the result of the student's independent research and preparation is required to demonstrate an independent research capability. The candidate is expected to defend his thesis and knowledge of his field in a final oral examination.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF FISHERIES AND WILDLIFE

| | | |
|---|---|---|
| 313 | Economic Ichthyology | 5 |
| 314 | Economic Ichthyology | 4 |

GRADUATE COURSES

| | | |
|---|---|---|
| 454 | Fishery Biology | 5 |
| 456 | Fishery Limnology | 3 |
| 457 | Fishery Limnology Laboratory | 2 |
| 465 | Commercial Fisheries | 5 |
| 466 | Invertebrate Fisheries | 4 |
| 470 | Water Pollution Biology | 3 |
| 490 | Parasites and Diseases of Fish | 5 |
| 555 | Fish Genetics | 3 |
| 561 | Theory of Exploitation of Fish and Shellfish | 4 |
| 567 | Research Methods | 4 |
| 568 | Research Methods | 4 |
| 569 | Research Methods | 4 |
| 570 | Pollution Problems in Fisheries | 3 |
| 571 | Ichthyology | 3 |
| 572 | Ichthyology | 3 |
| 573 | Ichthyology | 3 |

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

LOWER DIVISION

| | | |
|---|---|---|
| FST 111 | Food Quality Evaluation | 2 |
| FST 222 | Food Processing | 4 |
| FST 224 | Food Processing Laboratory | 2 |
| FST 271 | Food Grades and Sanitation | 2 |

UPPER DIVISION (courses designated (G) can be applied to a graduate major; courses designated (g) can be applied to a graduate monor only):

| | | |
|---|---|---|
| FST 411 | Food Science (g) | 3 |
| FST 412 | Food Science (g) | 3 |
| FST 421 | Federal and State Food Regulations (g) | 2 |
| FST 423 | Food Analysis (g) | 5 |
| FST 424 | Quality Control Systems (G) | 3 |
| FST 431 | Food Packaging (G) | 3 |
| AET 441 | Food Engineering | 3 |
| AET 442 | Food Engineering | 3 |
| AET 443 | Food Engineering | 3 |
| Mb 440 | Microbial Contamination Control (G) | 4 |
| Mb 444 | Food Microbiology (G) | 4 |

| | | |
|---|---|---|
| FST 401 | Research | arr |
| FST 403 | Thesis | arr |
| FST 405 | Reading and Conference | arr |
| FST 407 | Seminar | 1 |

GRADUATE COURSES

| | | |
|---|---|---|
| FST 501 | Research (G) | arr |
| FST 503 | Thesis (G) | arr |
| FST 505 | Reading and Conference (G) | arr |
| FST 507 | Seminar (G) | 1 |
| FST 531 | Carbohydrates in Foods (G) | 3 |
| FST 532 | Food Flavors and Evaluation (G) | 3 |
| FST 533 | Lipids in Foods (G) | 3 |
| FST 551 | Food Preservation (G) | 4 |
| FST 561 | Pigments and Color Evaluation (G) | 3 |
| FST 562 | Proteins in Foods (G) | 3 |
| FST 563 | Enzymes of Foods (G) | 3 |

The University also offers graduate programs in Marine Sciences and Ocean Engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF FISHERIES AND WILDLIFE

Bond, Carl E., Ph.D., Professor
Davis, Gerald E., Ph.D., Associate Professor
Donaldson, John R., Ph.D., Assistant Professor
Doudoroff, Peter, Ph.D., Professor
Fisher, R. Barry, M.A., Associate Professor
Hall, James D., Ph.D., Associate Professor
Horton, Howard F., Ph.D., Professor
Juntunen, Erland T., B.S., Instructor
McNeil, William J., Ph.D., Associate Professor
Millemann, Raymond E., Ph.D., Professor
Shumway, Dean L., M.S., Associate Professor
Simon, Raymond C., Ph.D., Professor
Warren, Charles E., Ph.D., Professor and Department Head (Acting)

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

Anderson, Arthur W., Ph.D., Professor, Microbiology
Anglemier, Allen F., Ph.D., Associate Professor, Food Science
Babbitt, Jerry K., Ph.D., Assistant Professor, Food Science
Beavers, Darrell V., B.S., Assistant Professor, Food Science
Bills, Donald D., Ph.D., Associate Professor, Food Science
Bodyfelt, Floyd W., M.S., Assistant Professor, Food Science
Booster, Dean E., M.S., Associate Professor, Agricultural Engineering
Cain, Robert F., Ph.D., Professor, Food Science
Crawford, David L., Ph.D., Associate Professor, Food Science
Elliker, Paul R., Ph.D., Department Chairman, Professor, Microbiology
Harvey, Edward W., Ph.D., Associate Professor, Food Science
Kirk, Dale E., M.S., Professor, Acting Head, Agricultural Engineering
Krumperman, Paul H., Ph.D., Associate Professor, Food Science
Law, Duncan K., B.S., Associate Professor, Food Science
Lee, Donald J., Ph.D., Assistant Professor, Food Science
Lee, Jong S., Ph.D., Associate Professor, Food Science
Libbey, Leonard M., Ph.D., Associate Professor, Food Science
McGill, Lois A., B.S., Associate Professor, Food Science
Montgomery, Morris W., Ph.D., Associate Professor, Food Science
Morgan, Max E., Ph.D., Professor, Food Science
Nixon, Joseph E., Ph.D., Assistant Professor, Food Science
Pawlowski, Norman E., Ph.D., Assistant Professor, Food Science
Samuels, Clifford E., Ph.D., Professor, Food Science
Sandine, William E., Ph.D., Professor, Microbiology
Scanlan, Richard A., Ph.D., Assistant Professor, Food Science
Schultz, Harold W., Ph.D., Department Head, Professor, Food Science
Sinnhuber, Russell O., M.S., Professor, Food Science
Soderquist, Michael R., M.S., Instructor, Food Science
Varseveld, George W., M.S., Assistant Professor, Food Science
Wales, Joseph H., M.A., Associate Professor, Food Science
Wrolstad, Ronald E., Ph.D., Assistant Professor, Food Sciences
Wyatt, Carolyn J., Ph.D., Assistant Professor, Food Science
Yang, Hoya Y., Ph.D., Associate Professor, Food Science
Yu, Teh C., M.S., Assistant Professor, Food Science

To obtain further information, address all inquiries directly to:

Dr. Charles E. Warren, Acting Head
Department of Fisheries and Wildlife
Oregon State University
Corvallis, Oregon 97331

Dr. Harold W. Schultz, Head
Department of Food Science and Technology
Oregon State University
Corvallis, Oregon 97331

## UNIVERSITY OF WASHINGTON
### SEATTLE, WASHINGTON

The College of Fisheries is located on the University of Washington Campus in the Fisheries Center Building. The Center houses classrooms, laboratories and general facilities as well as several research organizations.

The College has a collection of over 300,000 catalogued specimens of fishes for research and teaching purposes. It also has an experimental fish hatchery which developed and maintains the salmon run which is the basis for both instruction and research in the life cycle of Pacific salmon. A recirculating salt water aquarium is maintained for the study of the physiology and behavior of fish. There is, in addition, an extensive library of computer programs for processing biological data, and access to a Burroughs B5500, a Control Data Corporation 6400 computer, and a 200 Remote Terminal System.

The College of Fisheries field station at Big Beef Creek on Hood Canal provides additional opportunities for class field studies and research in stream and estuarine ecology. The Food Science facilities include separate well-equipped laboratories for food microbiology, food biochemistry and food analysis. A unique feature is the cobalt 60 research irradiator. A 67-foot diesel-powered boat, operated by the College, is capable of trawling to a depth of 1,000 fathoms and is equipped for other types of fishing as well as a wide variety of experimental work.

The following degrees are offered in the College of Fisheries:

1. Bachelor of Science in Fisheries (Fisheries Biology). A student may major in fishery science or fishery management and administration. To do this he must take courses in Introductory Biology or Zoology, General Chemistry, English, College Algebra, Elements of Statistical Methods and Fisheries 101, 240, 311, 314, 401, 456, 457, and 495. In addition he must complete the required courses for his selected option.

2. Bachelor of Science (Fisheries Biology). An elective curriculum is available for students desiring a Bachelor of Science with a major in fisheries. The student must complete 36 credits in fisheries and sufficient electives to meet the University graduation requirements (as generally outlined for the above degree). This degree is specifically intended for students desiring a strong minor (minimum of 30 credit hours) in a related field. The choice of electives is subject to approval by the College.

Prospective students are invited to inquire about additional areas of emphasis in which undergraduate preparation may be made. Such areas include behavior, biometrics, economics and water pollution.

3. Bachelor of Science (Food Science). To obtain this degree in the food science program the student must complete the requirements for University graduation with at least ten hours in humanities and biological studies. Courses in biochemistry, chemistry, mathematics, physics, preventive medicine and Fisheries 495 and Food Science 380, 481, 482, 483, 484, 485, 486, 487 and 498 are required.

4. Master of Science. Students must have a degree of bachelor of science in biological or physical science or fisheries or food science or the equivalent. At least one year of approved study with a completion of a research project and thesis leads to the Master's degree. A minimum of 45 upper division or graduate credits must be presented including 18 credits in Fisheries 700 or Food Science 700, six credits for Fisheries 520 or Food Science 521 and three additional credits in courses numbered 500 or above.

5. Doctor of Philosophy. Students must complete at least three years of graduate study including a dissertation. Credits earned for a Master's Degree may be applied toward the Doctor's degree. Students must demonstrate proficiency in the translation of one foreign language.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

ECONOMICS

| | | |
|---|---|---|
| 535 | Economics of Natural Resources | 3 |

FISHERIES

| | | |
|---|---|---|
| 101 | Introduction to Fisheries Science | 5 |
| 240 | Applications of Digital Computers to Biological Problems | 4 |
| 311 | Biology of Fishes | 3 |
| 314 | Methods and Instruments for Fishery Investigations | 1, Max 3 |
| 379 | Fisheries of the World | 3 |
| 401 | The Comparative Anatomy and Classification of Fishes | 5 |
| 405 | Economically Important Mollusca | 5 |
| 406 | Economically Important Crustacea | 5 |
| 425 | Life History of Marine Fishes | 5 |
| 451 | Reproduction of Salmonoid Fishes | 5 |
| 452 | Nutrition and Care of Fishes | 5 |
| 454 | Communicable Diseases of Fishes | 5 |
| 456 | Principles of Management of Natural Resources | 3 |
| 457 | Principles of Management of Natural Resources | 3 |
| 459 | Aquatic Food Chains | 5 |
| 460 | Water Management and Pollution Studies | 5 |
| 465 | Problems in Fish Biology | 6 |
| 471 | Principles of Aquatic Radioecology | 3 |
| 472 | Methods of Aquatic Radioecology | 3 |
| 473 | Radionuclides in the Aquatic Environments | 3 |
| 495 | Introduction to Fisheries and Food Science Literature | 2, Max 4 |
| 499 | Undergraduate Research | 1-3, Max 9 |
| 501 | On-the-job Training (Max 3 for M.S., 9 for Ph.D.) | 1-3 |
| 503 | Systematic Ichthyology | 5 |
| 504 | Invertebrate Pathology | 5 |
| 505 | Research Techniques in Shellfish Biology | 5 |
| 506 | Shellfish Sanitation | 5 |
| 507 | Topics in Fish Ecology- Max 15, | 1-5 |
| 510 | Fish Behavior | 3 |
| 511 | Fish Behavior Laboratory-Max 6, | 2-3 |
| 515 | Fish Physiology | 3 |
| 516 | Fish Physiology Laboratory | 2 |
| 520 | Graduate Seminar | Max 6, 2 |
| 530 | Biological Problems in Water Pollution | 3 |
| 531 | Seminar in Water Pollution Problems | 3 |
| 535 | Metabolic Effects of Chemical Pollutants | 4 |
| 540 | Application of Digital Computers to Problems in Aquatic Ecology | 3 |
| 545 | Speciation | 3 |
| 556 | Introduction to Quantitative Population Dynamics | 5 |
| 557 | Theoretical Models of Exploited Animal Populations | 5 |
| 558 | Estimation of Population Parameters | 5 |
| 600 | Research | * |
| 604 | Research (Max for M.S., Max 10 for Ph.D.) | * |

| | | |
|---|---|---|
| 700 | Master's Thesis | * |
| 800 | Doctoral Dissertation | * |

FOOD SCIENCE

| | | |
|---|---|---|
| **378** | Principles of Fishing Gear and Vessel Development | 3 |
| 380 | Principles of Fisheries Technology I | 3 |
| 381 | Principles of Fisheries Technology II | 3 |
| 481 | Introduction to Food Technology | 5 |
| 482 | Food Analysis I | 4 |
| 483 | Food Analysis II | 4 |
| 484 | Principles of Food Processing I | 5 |
| 485 | Principles of Food Processing II | 5 |
| 486 | Deteriorative Processes in Foods | 5 |
| 487 | Food Analysis III | 4 |
| 490 | Space Biology: Sealed Life-Support Systems | 3 |
| 504 | Principles of Technological Research in Food | Max 6, 5 |
| 521 | Graduate Seminar in Food Science | Max 6, 1 |
| 522 | Biological and Chemical Origins of Foods and Food Components and Their Functional Characteristics | 3 |
| 523 | Advanced Marine Food Processes | 5 |
| 524 | Microorganisms in Foods | 4 |
| 525 | Advanced Unit Operations in Food Processing | 3 |
| 526 | Advanced Unit Operations in Food Processing Laboratory | 3 |
| 600 | Independent Study or Research | * |
| 700 | Thesis | * |
| 800 | Doctoral Dissertation | * |

* The amount of credit is variable.

The Division of Marine Resources coordinates the work supported by Sea Grant funds being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering, Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business Law, Mechanical Engineering, Oceanography, and Zoology.

The University also offers undergraduate and graduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional Staff for the courses listed above consists of the following:

DEPARTMENT OF ECONOMICS

Crutchfield, James A., Jr., Ph.D., Professor

COLLEGE OF FISHERIES

Beasley, Thomas M., Ph.D., Research Associate Professor
Bell, Milo C., B.S., Professor
Bevan, Donald E., Ph.D., Professor
Bonham, Kelshaw, Ph.D., Research Professor
Brown, George W., Ph.D., Associate Professor
Burgner, Robert L., Ph.D., Professor and Director, Fisheries Research Institute
Chapman, Douglas G., Ph.D., Professor
Chew, Kenneth K., Ph.D., Associate Professor
DeLacy, Allan C., Ph.D., Professor
Donaldson, Lauren R., Ph.D., Professor
Hagen, Donald W., Ph.D., Assistant Professor and Curator of Fishes
Held, Edward, Ph.D., Research Professor
Hershberger, William K., Ph.D., Assistant Professor
Jones, G. Ivor, Ph.D., Acting Associate Professor
Kasahara, Hiroshi, Dr. of Agri., Professor and Associate Dean
Katz, Max, Ph.D., Research Professor
Liston, John, Ph.D., Professor and Director of Institute for Food Science and Technology
Matches, Jack, Ph.D., Acting Associate Professor
Mathisen, Ole A., Ph.D., Professor
McCaughran, Donald, Ph.D., Research Assistant Professor
Nakatani, Roy E., Ph.D., Acting Associate Professor
Olsen, Sigurd M., Research Assistant Professor
Paulik, Gerald J., Ph.D., Professor
Pigott, George M., Ph.D., Associate Professor
Riddle, Victor M., Ph.D., Assistant Professor
Rogers, Donald E., Ph.D., Research Assistant Professor
Rothschild, Brian J., Ph.D., Associate Professor
Royce, William F., Ph.D., Professor and Associate Dean
Saddler, James B., Ph.D., Research Assistant Professor
Salo, Ernest O., Ph.D., Professor
Seymour, Allyn H., Ph.D., Professor and Director of Laboratory of Radiation Ecology
Smith, Lynwood S., Ph.D., Associate Professor
Stober, Quentin J., Ph.D., Research Assistant Professor
Taub, Frieda B., Ph.D., Acting Associate Professor
Thorslund, Todd W., Sc.D., Assistant Professor
Van Cleve, Richard, Ph.D., Professor and Dean
Welander, Arthur D., Ph.D., Professor
Whitney, Richard R., Ph.D., Associate Professor
Wydoski, Richard S., Ph.D., Assistant Professor

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

# *CURRICULA IN*

# *MARINE LAW*



445-776 O - 71 - 13

## LOUISIANA STATE UNIVERSITY
BATON ROUGE, LOUISIANA

In the spring, 1970, the Louisiana State University Law School began use of its new Law Center which contains extensive classroom and research facilities. Particular emphasis has been given, with assistance from the Office of Sea Grant Programs (National Oceanic and Atmospheric Administration), to the acquisition of a comprehensive library in the field of marine resources law. Individual enclosed research carrels are available for use by graduate students, and the staff and facilities of the University's Center for Wetland Resources are available for interdisciplinary research and consultation. (See the Marine Sciences and Fisheries sections of this publication for other L.S.U. programs.)

The LL.M. (Master of Laws) with specialization in Marine Resources Law and Policy is offered. This degree program, to be initiated in the fall, 1971, requires degree candidates to possess the LL.B. or J.D. degree. The required courses (minimum of 24 semester hours) are divided between the law school and the Department of Marine Sciences, so that the candidate is exposed to scientific and technical material in the marine resources field as well as legal aspects. A thesis must be submitted and defended, and a minimum of two semesters residence is required. The emphasis of the program is on administrative aspects (both public and private) of marine and coastal resource conservation and development, and its purpose is to train tomorrow's decision makers for industry, government, and private law practice in the field of marine and coastal resource conservation and development.

The following courses are offered in conjunction with the above programs:

SCHOOL OF LAW

| | | |
|---|---|---|
| 157 | International Law | 3 |
| 164 | Marine Resources Law I | 3 |
| 165 | Marine Resources Law II | 3 |
| 166 | Seminar in Public Land Management | 2 |
| 190 | Seminar in Oil and Gas | 2 |
| | Directed Research in Marine Resources Law | 4 |

The University also offers graduate programs in Marine Sciences and Fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

SCHOOL OF LAW

Hardy, George W., III, J.D., Professor
Knight, H. Gary, J.D., Assistant Professor

To obtain further information, address all inquiries directly to:

H. Gary Knight, Director
Graduate Program in Marine Resources Law
L.S.U. Law Center
Baton Rouge, Louisiana 70803

## UNIVERSITY OF MIAMI
CORAL GABLES, FLORIDA

The following degrees in Ocean Law are offered by the University:

1. LL.M. (Master of Laws) in Ocean Law. All students are required to complete twenty course credits and successfully defend a thesis. Two course credits in the marine sciences are required, and up to six marine science credits may be recognized towards the degree. The required marine science course, The Ocean and Its Resources, is designed for the Ocean Law candidates. The degree is offered by the School of Law. A law faculty member specializing in Ocean Law serves as the advisor to each student and approves his study program.
2. Ocean Law Specialization in J.D. (Juris Doctor) Studies. The Ocean Law area of concentration offers an opportunity to specialize in the legal problems of the ocean environment while completing requirements for the basic J.D. law degree. The subjects of study include the law applicable to the various uses of the ocean and coastal regions, and pollution law, as well as the commonly available subject of admiralty law. These courses are taken during the second and third years of law study.

Interdisciplinary study in cooperation with the Rosenstiel School of Marine and Atmospheric Sciences is available to qualified seniors through the course The Ocean and its Resources.

Students electing the Ocean Law area of concentration will normally take the prerequisite International Law course in the first semester of their second year in law school and Ocean Law in the first semester of their third year. The courses in the program are listed below.

Students whose general law school average and average in courses in this program is 75 or higher will be recognized as having concentrated in Ocean Law after completion of ten credits in the courses listed below under the School of Law.

The following courses are offered in conjunction with the above programs:

SCHOOL OF LAW

GRADUATE COURSES

| | | |
|---|---|---|
| 806 | Admiralty | 3 |
| 819 | Ocean Law | 2-3 |
| 823 | Coastal Legal Problems | 3 |
| 850 | Environmental Law Seminar | 3 |
| 866 | International Law | 3 |
| 869 | Marine Pollution Law | 2-3 |
| 985 | Ocean Law Seminar | 2 |
| 991 | Individual Research in Ocean Law | 1-3 |

DEPARTMENT OF ECONOMICS

| | | |
|---|---|---|
| 685 | Economics of Natural Resources | 3 |

SCHOOL OF MARINE AND ATMOSPHERIC SCIENCES

| | | |
|---|---|---|
| 501 | Fishery Biology | 3 |
| 607 | Ocean Engineering Seminar | 1 |
| 676 | The Ocean and Its Resources (required) | 2 |

The University also offers graduate programs in Marine Science, Fishery Science and Ocean Engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Clingan, Thomas A., Jr., J.D., Professor of Law
O'Connor, Dennis M., LL.B., Professor of Law and Oceanography

To obtain further information, address all inquiries directly to:

School of Law
University of Miami
Coral Gables, Florida 33124

## UNIVERSITY OF OREGON SCHOOL OF LAW
EUGENE, OREGON

The Law School offers courses at the legal center building on the University of Oregon campus in Eugene, Oregon. An Ocean Law library and the facilities of the Law School library are used for research. In conjunction with the Marine Advisory Program, the Law School plans to conduct seminars at the law center or at various coastal locations, attended by members of Oregon ocean industries, Oregon State University oceanographers, other scientists, Oregon Law School faculty members, and interested members of the bar and government.

The Oregon Law School ocean law program is part of the Oregon State University Sea Grant administration. The J.D. degree is offered.

The following courses are offered in conjunction with the above programs:

| | |
|---|---|
| Ocean Resources Law Seminar | 3 |
| Environmental Quality Seminar | 3 |
| Natural Resources Seminar | 3 |

The University also offers undergraduate and graduate programs in marine science which are described in the Marine Science section of this publication.

The instructional staff for the cou listed above consists of the following:

Barry, Frank J., LL.B., Professor of Law
Clark, Chapin D., LL.M., Professor of Law
Jacobson, Jon L., J.D., Assistant Professor of Law
Swan, Peter N., LL.B., Associate Professor of Law

To obtain further information, address all inquiries directly to:

Professor Jon L. Jacobson
University of Oregon School of Law
Eugene, Oregon 97403

# *CURRICULA FOR*

# *MARITIME OFFICERS*

## CALIFORNIA MARITIME ACADEMY
### VALLEJO, CALIFORNIA

The Academy is situated on a 67-acre campus adjacent to the Carquinez Straits. A deep water pier provides berthing space for the training ship GOLDEN BEAR and encloses a boat basin for power, sailing, and rowing boats.

An engineering building, Dwyer Hall, completed in 1961, provides office space for the Marine Engineering Department and classroom and laboratory facilities for instruction in chemistry, physics, electricity, electronics, diesel engines, machine shop and welding and burning.

The Federal Maritime Administration has provided the academy with a modern 7,040 ton twin screw, turbo-electric drive, 16-knot vessel for the purpose of conducting the annual sea training period of approximately three months. The training ship GOLDEN BEAR is operated entirely by the midshipmen under the supervision of the Academy's licensed officer-instructors. The GOLDEN BEAR provides a modern training vessel for the actual performance of deck and engineering skills at sea. The ship is fitted with classrooms, a machine shop and the most modern equipment, including steam and diesel powered auxiliaries as well as turbo-electric propulsion. Reading and recreation rooms provide the necessary facilities for off-duty activities.

The Bachelor of Science degree in Nautical Science or the Bachelor of Science degree in Marine Engineering is conferred upon Midshipmen successfully completing the Academy program of instruction and the U.S. Coast Guard license examination.

The following courses are offered by the Departments indicated in conjunction with the above degrees:

DEPARTMENT OF NAUTICAL SCIENCE

| | |
|---|---|
| D-108 | Navigation |
| D-110 | Engineering Graphics |
| D-111 | Seamanship |
| D-112 | Rules of the Road |
| D-115 | Marlinspike Seamanship |
| D-116 | Marlinspike Seamanship |
| D-117 | Boats |
| D-118 | Boats |
| D-125 | Ship's Operations |
| D-126 | Ship's Operations |
| D-201 | Navigation |
| D-202 | Navigation |
| D-205 | Physics I (Mechanics) |
| D-206 | Physics II (Electricity) |
| D-207 | Ship Construction |
| D-208 | Maritime Economics |
| D-210 | Ship Stability |
| D-212 | Rules of the Road |
| D-215 | Applied Seamanship |
| D-216 | Applied Seamanship |
| D-222 | Instruments and Navigational Aids |
| D-223 | Communications |
| D-225 | Ship's Operations |
| D-226 | Ship's Operations |
| D-301 | Navigation |
| D-302 | Navigation |
| D-303 | Meteorology |
| D-304 | Maritime Law |
| D-305 | Radar |
| D-306 | Marine Rules and Regulations |
| D-308 | License Seminar |
| D-309 | Cargo I |
| D-310 | Cargo II |
| D-311 | Seamanship |
| D-312 | Rules of the Road |
| D-323 | Communications |
| D-325 | Ship's Operations |
| D-326 | Ship's Operations |

DEPARTMENT OF MARINE ENGINEERING

| | |
|---|---|
| E-107 | Chemistry I |
| E-108 | Chemistry II |
| E-109 | Engineering Graphics |
| E-110 | Physics I |
| E-111 | Steam Engineering I |
| E-112 | Steam Engineering II |
| E-113 | Maritime Economic History |
| E-115 | Boats |
| E-116 | Boats |
| E-118 | Machine Shop Lab |
| E-120 | Machine Shop Laboratory I |
| E-208 | Machine Shop Theory |
| E-201 | Steam Engineering III |
| E-202 | Steam Engineering IV |
| E-203 | D-C Electrical Engineering |
| E-204 | A-C Electrical Engineering |
| E-205 | Physics II |
| E-212 | Thermodynamics |
| E-216 | DC Electrical Laboratory |
| E-217 | Machine Shop Lab |
| E-218 | Marine Machinery Lab III |
| E-220 | Arc and Gas Welding |
| E-221 | Refrigeration and Air Conditioning |
| E-223 | Marine Machinery Lab II |
| E-301 | Steam Engineering V |
| E-302 | Steam Engineering VI |
| E-303 | Diesel Engineering |
| E-304 | Diesel Engineering |
| E-305 | Engineering Materials |
| E-306 | Ship Construction and Damage Control |
| E-307 | Automation Principles |
| E-308 | Electronics |
| E-310 | Nuclear Power |
| E-312 | Engineering Administration |
| E-314 | Labor Relations |
| E-315 | Diesel Laboratory |
| E-316 | Machinery Analysis Laboratory |
| E-317 | AC Electrical Laboratory |
| E-318 | License Seminar |
| E-319 | Marine Machinery Lab IV |
| E-320 | Marine Machinery Lab V |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF NAUTICAL SCIENCE

Aguilar, CDR William H., B.S., CMA, Masters License unlimited, USNR (Ret.), Master Mariner, Head of Department
Aschemeyer, LT Manfred H.K., B.S., CMA, Federal License: master, steam and motor vessels, ocean unlimited
Craig, LT Robert, B.S., CMA, Federal License: third mate, steam and motor vessels, ocean, unlimited
Heron, CDR Richard D., CMA, CDR USNR, Federal License: chief mate, steam and motor vessels, ocean unlimited
Newton, LCDR Fred B., Jr., LCDR USN (Ret.), Federal License: master, steam and motor vessels, ocean, unlimited
Ruff, LT William T., B.S., CMA, Federal License: master, steam and motor vessels, ocean, unlimited
Wood, LT Philo, CDR USN (Ret.), A.B., Federal License: master, steam and motor vessels, ocean, unlimited

DEPARTMENT OF MARINE ENGINEERING

Barber, Mr. William, M.S.

Behm, LCDR Arthur S., Jr., B.S., CMA, LT USNR, Federal License: chief engineer, steam vessels, ocean, unlimited
Beland, LT Thomas J., B.A., Federal License: second assistant engineer, steam vessels, ocean, unlimited
Branin, LT Samuel W., B.A., LCDR USCG (Ret.), Federal License: chief engineer steam vessels, ocean, unlimited
Bruhn, CDR Otto J., LT USNR, Federal License: chief engineer, steam vessels, ocean, unlimited, Head of Department
LaBombard, LT Frank L., CHMACH W-4 USNR, Federal License: second assistant engineer, steam vessels, ocean, unlimited
Nilson, LT Norman, B.S., third assistant engineer, steam and motor, ocean, unlimited
Thor, LT Howard A., Ph.D., LTJG, Federal License: first assistant engineer, steam, and third assistant engineer, motor vessels, ocean, unlimited

To obtain further information, address all inquiries directly to:

Mr. Louis E. Kiger
Public Information Officer
California Maritime Academy
Box 1392
Vallejo, California 94590

## MAINE MARITIME ACADEMY
CASTINE, MAINE

The Academy offers marine science courses utilizing the 10,000 ton steam training vessel STATE OF MAINE, the 75-foot training vessel PATHFINDER, and a number of yachts ranging in size from 27 feet to 60 feet as well as several motor launches and work boats. The training vessels are equipped with all the normal electronic gear, such as radar, loran, fathometers, etc. The yachts and launches can be used for small parties and nearby activities. Castine is a deep-water harbor, accommodating deep-draft ships, and the Academy's wharves are adequate. The dock-side facilities include a machine shop, forge and foundry, a steam laboratory and marine engineering laboratory equipped with an atomic reactor and associated equipment for the nuclear propulsion training program. This building also contains a classroom equipped for electronic navigation training, engineering classrooms, a marlinespike seamanship laboratory, and a steam and electric power laboratory. Currently being constructed are a 2 foot x 8 foot x 3 inch towing tank and a scale model tanker in a tank with a full size cargo control room simulator. The former will be used in connection with naval architecture courses and the latter will have capabilities for instruction in stability, cargo loading and discharging, and anti-pollution control.

The following degrees are offered:

1. B.S. in Marine Science (Department of Nautical Science). The curriculm offered by this department gives the professional courses which are required to qualify the deck student to receive a degree and, after passing the required U.S. Coast Guard examination, a Federal license in the Merchant Marine. This curriculum is designed to familiarize the deck student with all phases of navigation and piloting, rules and regulations, deck seamanship, cargo handling and stowage, visual signaling, ship handling and management.

2. B.S. in Marine Engineering (Department of Marine Engineering). The Engineering Department offers courses which pertain directly to design, operation and maintenance of marine power plants. These courses are required to qualify the engineering student to receive a degree and, after passing the required U.S. Coast Guard examination, a Federal license in the Merchant Marine. The department not only offers a thorough training in the fundamentals of engineering, but also coordinates theory and practice by relating classroom studies to the student's practical experience aboard ship and in the on-campus functional training engineering laboratory.

The Department of General Education offers both core and elective courses in order to enrich the professional Deck or Engineering student's background. All students are required to present 18 semester credit hours in an elective minor area.

The following courses are offered in conjunction with the above programs:

DEPARTMENT OF NAUTICAL SCIENCE

| | | |
|---|---|---|
| Ns 1 | Deck Indoctrination | 3 |
| Ns 2 | Ship Structure | 3 |
| Ns 3 | Deck Drawing | 1.5 |
| Ns 4 | Stability | 2 |
| Ns 5 | Meteorology I | 3 |
| Ns 6 | Meteorology II | 1 |
| Ns 7 | Cargo I | 3 |
| Ns 8 | Cargo II | 3 |
| Ns 9 | Deck Mathematics | 1 |
| Ns 10 | Seamanship I | 2 |
| Ns 11 | Seamanship II | 3 |
| Ns 12 | Seamanship III | 3 |
| Ns 13 | Seamanship IV | 1 |
| Ns 14 | Rules and Regulations I | 3 |
| Ns 15 | Rules and Regulations II | 1 |
| Ns 16 | Rules of the Road I | 2 |
| Ns 17 | Rules of the Road II | 2 |
| Ns 18 | Pilot Rules | 2 |
| Ns 19 | Rules of Nautical Road | 2 |
| Ns 20 | Communications I | 1 |
| Ns 21 | Communications II | 1 |
| Ns 22 | Marlinespike | 1.5 |
| Ns 23 | Lifeboat | 1 |
| Ns 30 | Plane Sailing Navigation | 3 |
| Ns 31 | Celestial Navigation I | 3 |
| Ns 32 | Celestial Navigation II | 3 |
| Ns 33 | Celestial Navigation III | 2 |
| Ns 34 | Electronic Navigation I | 2 |
| Ns 35 | Electronic Navigation II | 2 |
| Ns 36 | General Navigation I | 3 |
| Ns 37 | General Navigation II | 2 |
| Ns 40 | Ship Business and Industrial Relations | 2 |

DEPARTMENT OF MARINE ENGINEERING

| | | |
|---|---|---|
| Eg 1 | Engineering Fundamentals | 2.5 |
| Eg 2 | Electicity | 3 |
| Eg 3 | Engineering Graphics | 3 |
| Eg 4 | Applied Hydraulics | 3 |
| Eg 5 | Automation | 3 |
| Eg 6 | Engineering Mathematics | 2 |
| Eg 7 | Steam Engines | 1.5 |
| Eg 8 | Engine Safety | 1.5 |
| Eg 10 | Electrical Engineering I | 3 |
| Eg 11 | Electrical Engineering II | 3 |
| Eg 12 | Electrical Engineering III | 3 |
| Eg 14 | Steam Generators I | 3 |
| Eg 15 | Steam Generators II | 3 |
| Eg 17 | Steam Propulsion I | 3 |
| Eg 18 | Steam Propulsion II | 3 |
| Eg 19 | Steam Propulsion III | 3 |

| | | |
|---|---|---|
| Eg 21 | Engineering Lab I | 2 |
| Eg 22 | Engineering Lab II | 2 |
| Eg 24 | Machine Tool Operation I | 2.5 |
| Eg 25 | Machine Tool Operation II | 2 |
| Eg 26 | Machine Tool Operation III | 2 |
| Eg 28 | Nuclear Engineering I | 2.5 |
| Eg 29 | Nuclear Engineering II | 2.5 |
| Eg 31 | Diesel Engineering I | 3 |
| Eg 32 | Diesel Engineering II | 1.5 |
| Eg 34 | Refrigeration | 2 |
| Eg 35 | Refrigeration and Air Conditioning | 1.5 |
| Eg 40 | Ship Business and Industrial Relations | 2 |

DEPARTMENT OF GENERAL EDUCATION

| | | |
|---|---|---|
| As 10 | Introductory Astronomy | 3 |
| Ec 10 | Marine Shipping Economics | 3 |
| Lw 1 | Admiralty Law | 3 |
| Na 10 | Statics for Ship Design | 3 |
| Na 30 | Strength of Materials for Ship Construction | 3 |
| Na 31 | Fluid Mechanics and Dynamics of Ships | 3 |
| Na 32 | Applied Naval Architecture | 3 |
| Na 33 | Ship Construction and Inspection | 3 |
| Oc 1 | Introduction to Oceanography | 3 |
| Oc 10 | Geological Oceanography | 3 |
| Oc 11 | Physical and Chemical Oceanography | 3 |
| Oc 12 | Biological Oceanography | 3 |
| Oc 13 | Ocean Research Vehicles and Equipment | 3 |
| Oc 30 | Ocean Research | 3 |
| Tr 10 | Marine Transportation | 3 |
| Tr 11 | Marine Insurance | 3 |
| Tr 12 | Ocean Traffic and Export-Import Practice | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF NAUTICAL SCIENCE

Campbell, Thomas, B.S., Master Mariner, Oceans Unlimited, Instructor in Nautical Sciences
Geissler, Edward J., B.S., B.S.F.S., Master Mariner, Oceans Unlimited, Instructor in Nautical Science
Hathaway, Louis S., B.S., Master Mariner, Oceans Unlimited, Instructor in Nautical Science
Nichols, Joseph F., Instructor of Stability and Ship's Structure
Sawyer, Sherman G., Master Mariner, Oceans Unlimited, Instructor in Navigation
Terry, Russell H., Master Mariner, Oceans Unlimited, Chairman and Instructor of Navigation

DEPARTMENT OF ENGINEERING

Brown, Edward F., Chief Engineer, Steam Unlimited, Chairman and Instructor of Diesel Engineering
Creighton, Franklyn W., Chief Engineer, Steam and Diesel, Unlimited, Instructor of Engineering
Goodwin, Francis X., B.S., Third Assistant Engineer, Steam and Diesel, Instructor of Engineering
Jacobs, George P., Second Assistant Engineer, Steam, Instructor of Engineering
Markley, John P., Chief Engineer, Steam and Diesel, Unlimited, Instructor of Engineering
Marks, Roger A., Second Assistant Engineer, Oceans Unlimited, Instructor of Engineering
Robinson, Charles S.L., S.M., Instructor in Nuclear Engineering
Snow, John F., Third Assistant Engineer, Steam Unlimited, Instructor in Electricity
Spinazola, Eugene H., Second Assistant Engineer, Steam and Diesel, Instructor in Nuclear Propulsion
Wiles, James F., Chief Engineer, Steam and Diesel, Unlimited, Instructor of Engineering

DEPARTMENT OF GENERAL EDUCATION

Barlow, John, Ph.D., Instructor of Oceanography
Kee, David W., A.B., J.D., Instructor of Admiralty Law
Kennaday, John M., Ed.M., Instructor of Astronomy
Poor, P. Thurston, B.A., Chairman and Instructor in English
Rice, Harold A., M.A., M.A.L.D., Instructor of Marine Shipping Economics and Transportation
Wyman, David B., M.S., Instructor in Oceanography and Naval Architecture

N.B., Maine Maritime Academy does not use a professorial system, all teachers are designated as Instructor.

To obtain further information, address all inquiries directly to:

CAPT Edward E. Conrad, Academic Dean
Maine Maritime Academy
Castine, Maine 04421

LCDR David G. Buchanan, Director of Admissions
Maine Maritime Academy
Castine, Maine 04421

## THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK
FORT SCHUYLER, BRONX, NEW YORK

(For a complete description of the College's facilities, please refer to the College's listing in the Marine Sciences section of this publication.)

1. Marine Transportation Science (BS) Program.

The students who successfully complete the courses offered in the Marine Transportation Science Program receive the degree of Bachelor of Science and, after passing the required U.S. Coast Guard examinations, a Federal license as Third Mate in the Merchant Marine. Registered as a general purpose degree, the Bachelor of Science degree of Marine Transportation Science majors satisfies all the requirements of the Court of Appeals for admission to law schools in New York State. If acceptable in all respects, the graduate of this program can obtain a commission as Ensign in the U.S. Naval Reserve.

The Marine Transportation Science curriculum consists of courses in Nautical Science, Marine Navigation, Ocean Transportation, Maritime Law; and Economics-Principles, Geo-

graphy, International Trade and Labor.

The course of study for students majoring in Marine Transportation Science includes the theoretical and practical education necessary to develop highly qualified licensed officers. It combines the humanities and sciences with nautical and marine transportation subjects to achieve a well-rounded collegiate program which will fully equip a young man to meet the present and future problems of life and the needs of the maritime industry, afloat and ashore. Theory and practice are integrated by relating the scholastic efforts of academic year ashore to those of the Summer Sea Training Program (S.S.T.P.) aboard the college training ship during the summer months.

The Summer Sea Term (S.S.T.) is made up of two sessions, each approximately six weeks long. Every third (sophomore) and second (junior) classman is required to take one of the two sessions each summer. The first (senior) classmen are required to take both sessions of the Summer Sea Term. The summer voyages are required, credit bearing, staff supervised educational periods intended to insure necessary operational experiences for all cadets. In order to be graduated, every student must successfully pass each of the three indicated summer periods on the college training vessel. The sea period grade is a report for a single course that is made up of several phases and requirements. Failure may result in repeating the period or disenrollment for inaptitude. Each succeeding period at sea will demand of the student the assumption of additional supervisory responsibilities and advanced operational knowledge. The Summer Sea Term begins about 1 June and ends about 1 September.

The objectives of the Summer Sea Term are accomplished by on-the-job training, by actual watch standing and ship work, and instruction through formal class periods which are designed to enhance the professional knowledge of the students. All phases of the program are conducted by experienced licensed officers and the cadets make use of the modern nautical equipment aboard the ship. Training aids are utilized when actual equipment is either not available or cannot be easily visualized.

2. Marine Transportation Management (MS) Program.

In its Master of Science Program, the Department of Marine Transportation of the Maritime College provides graduate level education in the field of marine transportation management by: developing in the student a pattern of original and creative thought; developing skill in analyzing and solving problems; indentifying the vital issues confronting the maritime industry.

The program will, at least for the present, be for part-time, primarily evening students. The general requirements for the degree are as follows:

(1) A minimum of 33 credits of appropriate graduate study.

(2) A minimum cumulative average of 3.0 in all courses accepted toward the degree.

(3) Residence: equivalent of one year (completion of 24 credits of part-time study)

(4) Research and thesis.

(5) Passing of a comprehensive examination.

Core Requirements (0-9 credits toward degree): A candidate for the degree must take the following core requirements, unless he has completed equivalent courses. A maximum of nine core credits can be applied to fulfill the minimum of 33 credits needed for the master's degree.

| | | |
|---|---|---|
| 1501 | Intensive Accounting | 3 |
| 2501 | Economic Analysis | 3 |
| 2301 | Business Management | 3 |
| 2407 | Marketing | 3 |
| 2409 | Finance: Money and Capital Markets | 3 |
| 3501 | Analysis of Ocean Transportation | 3 |
| 3502 | Managerial Statistics I | 3 |
| 4501 | Intensive Survey of Business Law | 3 |

Specialization requirements (18 credits toward degree): In addition to the core requirements, the program will include all courses listed below not previously completed. A student must supplement the specialization requirements by taking sufficient electives to complete the total of 33 credits required for the degree. Nine of these credits may be from the core requirements courses, but only when taken from the courses specified above.

| | | |
|---|---|---|
| 2504 | Analysis of Maritime Industrial Relations | 3 |
| 3503 | Managerial Statistics II | 3 |
| 3506 | Management of International Trade | 3 |
| 3507 | Introduction to Systems Analysis and Operations Research | 3 |
| 3512 | Governmental Regulation of Water Transportation | 3 |
| or | | |
| 2507 | Economics of International Trade | 3 |
| 3601 | Thesis Seminar I | 1 |
| 3602 | Thesis Seminar II | 2 |

Electives: The courses listed are illustrations of the range of offerings. Those offered in any term depend upon potential enrollment.

| | | |
|---|---|---|
| 1502 | Cost Accounting for Management | 3 |
| 1503 | Steamship Managerial Accounting | 3 |
| 2502 | Transportation Geography | 3 |
| 2503 | Latin American Business | 3 |
| 2505 | Financial Analysis | 3 |
| 2506 | Managerial Economics | 3 |
| 3504 | Ocean Marine Cargo and Hull Insurance | 3 |
| 3505 | Ocean Marine Insurance Loss Adjusting | 3 |
| 3508 | International Air Transportation | 3 |
| 3509 | Advanced Chartering Problems | 3 |
| 3510 | Tanker Management and Operation | 3 |
| 3511 | Ports and Port Facilities | 3 |
| 3513 | Comparative Transportation Systems | 3 |
| 3514 | Behavioral Science | 3 |
| 3603 | Seminar in Maritime Management Problems | 3 |
| 3604 | Seminar in Advanced Materials Handling | 3 |
| 4502 | Intensive Survey of Admiralty Law | 3 |
| 5501 | Data Processing Systems | 3 |

The instructional staff for the courses listed above consists of the following:

MARINE TRANSPORTATION DEPARTMENT

De Simone, Guy J., Master Mariner, M.B.A.,

Chairman and Professor of Marine Transportation
Dutcher, Lester A., Master Mariner, M.B.A., Associate Professor of Marine Transportation
Gallo, Francis X., Chief Mate (Unlimited), M.B.A., Instructor of Marine Transportation
Hart, John C., J.D., Lecturer in Admiralty Law
Millington, Herbert, Ph.D., Professor of Economics
Mueller, Frank W., B.S.E.E., Instructor of Marine Electronics
Nolan, Gerard, Master Mariner, B.S., Executive Officer of Training Ship and Professor of Marine Transportation
Parnham, Harold A., Master Mariner, M.A., Associate Professor of Marine Transportation
Sembler, William, Master Mariner, M.B.A., Professor of Marine Transportation
Smukler, Philip R., M.A., Assistant Professor of Economics
Vambery, Robert G., M.S., Assistant Professor of Economics
Van Wart, Donald W., Chief Mate (Unlimited), M.B.A., Associate Professor of Marine Transportation

To obtain further information, address all inquiries directly to:

Professor Guy J. De Simone, Chairman
Department of Marine Transportation
State University of New York
Maritime College
Fort Schuyler, Bronx, New York 10465

## MASSACHUSETTS MARITIME ACADEMY
### BUZZARDS BAY, MASSACHUSETTS

Massachusetts Maritime Academy presently offers two four-year curricula. One leads to a Bachelor of Science degrre in Marine Transportation and a Federal License as Third Mate, Steam and Motor Vessels, and the other leads to a Bachelor of Science degree in Marine Engineering and a Federal License as Third Assistant Engineer, Steam and Motor Vessels. Either program provides the cadet with a sound foundation in mathematics, physical science, hamanities and social studies, as well as in required professional subjects. Three ten-week sea training cruises on the BAY STATE prepare the graduate to function effectively as an officer aboard the ships of the United States Merchant Marine. Courses in Naval Science qualify graduates to apply for a commission as Ensign, United States Naval Reserve.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| 231 | Meteorology | 2 |
| 232 | Oceanography | 2 |
| 422 | Economics of the Maritime Transportation Industry | 2 |
| 441 | Maritime Law | 2 |
| 446 | Marine Insurance | 2 |
| 511 | Principles of Naval Organization and Management | 2 |
| 512 | Principles of Naval Organization and Management | 2 |
| 541 | Naval Science Seminar | .5 |
| 542 | Naval Science Seminar | .5 |
| 635 | Modern Ship Construction | 2 |
| 641 | Ship Stability and Trim | 2 |
| 713 | Introduction to Marine Engineering | 2 |
| 721 | Marine Boilers | 3 |
| 722 | Propulsion | 3 |
| 723 | Auxiliary Machinery | 3 |
| 731 | Internal Combustion Engines | 3 |
| 732 | Electrical Engineering, DC | 3 |
| 733 | Electrical Engineering, AC | 3 |
| 741 | Casualty and Damage Control | 3 |
| 742 | Nuclear Engineering | 3 |

The instructional staff for the courses listed above consists of the following:

Burnhardt, David, Associate Professor
Ceely, Henry, Assistant Professor
Crosby, James, Assistant Professor
Dorsey, Thomas, Assistant Professor
Earle, William, Associate Professor
Hemmerly, William, Assistant Professor
Jenson, LCDR Richard (USN)
Johansen, Paul, Associate Professor
Maloney, Lt. Eugene (USNR)
Murray, James, Assistant Professor
Wright, Frederick, Assistant Professor

To obtain further information, address all inquiries directly to:

Dr. Frederick J. Hancox
Dean
Massachusetts Maritime Academy
Buzzards Bay, Massachusetts 02532

## TEXAS MARITIME ACADEMY
### TEXAS A&M UNIVERSITY
### GALVESTON, TEXAS

The school year consists of two semesters in fall and spring for four years and three summer training cruises. The cruises are aboard the training ship, a former passenger-cargo liner of 15,000 tons and 16 knots, provided by the U. S. Government. Cruises are of about ten weeks duration. Each year the cruise is scheduled to different parts of the world. Classes are conducted aboard ship, and each student performs duties which supplement theoretical studies ashore.

Classes for the freshman year are conducted at Texas A&M University at College Station, Texas. The last three years are spent at the Texas Maritime Academy at Galveston.

The Academy was started with its first class in 1962, as the fifth State Maritime Academy of the United States. The first two buildings of a new campus on Pelican Island, Galveston, are now under construction. The new Texas Maritime Academy will constitute a part of the Moody Marine Institute on Pelican Island; such institute will also include some of Texas A&M University's oceanographic activities, and, also some of the activities of Gulf Universities Research Corporation.

Two degree courses of study are offered - Marine Engineering and Marine Transportation. Each course consists of four years of college and professional education. Upon successful completion of the prescribed course of study and three training cruises, the graduate will receive a Bachelor of Science degree from Texas A&M University in Marine Engineering or in Marine Transportation. The degree qualifies the graduate to take the United States Coast Guard license examination for Third Mate or Third Assis-

tant Engineer, and thus leads to a career in the U. S. Merchant Marine.

The following courses are offered in conjunction with the above programs:

MARINE TRANSPORTATION

| | | |
|---|---|---|
| 101 | Maritime Orientation | 1 |
| 311 | Navigation | 3 |
| 301 | Ocean Transportation I | 4 |
| 302 | Marine Cargo Operation | 3 |
| 304 | Ocean Transportation II | 3 |
| 402 | Ocean Transportation III | 4 |
| 406 | Marine Cargo Operations | 3 |
| 200 | Basic Communications, Navigation, and Seamanship | 4 |
| 201 | Naval Architecture I | 3 |
| 202 | Naval Architecture II | 2 |
| 203 | Seamanship I | 3 |
| 204 | Terrestrial Navigation | 3 |
| 300 | Intermediate Communications, Navigation, and Seamanship | 4 |
| 301 | Seamanship II | 3 |
| 302 | Seamanship III | 2 |
| 303 | Celestial Navigation | 3 |
| 304 | Electronic Navigation | 3 |
| 400 | Advanced Communications, Navigation, and Seamanship | 4 |
| 401 | Seamanship IV | 3 |
| 404 | The Navigator | 3 |

MARINE ENGINEERING

| | | |
|---|---|---|
| 201 | Marine Engineering Mechanics | 3 |
| 301 | Fluid Mechanics and Heat Transfer | 3 |
| 303 | Marine Thermodynamics | 3 |
| 304 | Marine Thermodynamics | 3 |
| 305 | Strength of Materials | 3 |
| 306 | Marine Refrigeration and Air Conditioning | 3 |
| 307 | Electrical Circuits | 4 |
| 308 | Electrical Machinery | 4 |
| 401 | Nuclear Propulsion I | 3 |
| 402 | Diesel Engineering | 3 |
| 403 | Marine Steam and Gas Turbines | 3 |
| 405 | Steam Generators | 3 |
| 406 | Engineering Repairs | 2 |
| 408 | Nuclear Propulsion II | 3 |
| 414 | Ship Automation | 4 |
| 415 | Nuclear Propulsion III | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF MARINE TRANSPORTATION

Armstrong, Robert W., B.S., Master Mariner, Assistant Professor, Marine Cargo Operations
Lane, John M., B.S., Master Mariner,. Assistant Professor, Ocean Transportation
McMullen, William T., B.S., Second Mate, Assistant Professor, Navigation
Philbrick, Alfred R., B.S., Master Mariner's License, Head, Department of Marine Transportation, Associate Professor; Master of Training Ship TEXAS CLIPPER
Plant, Richard, B.S., Third Mate, Assistant Professor Seamanship

DEPARTMENT OF MARINE ENGINEERING

Crosby, Gary A., M.S., Third Assistant Engineer, Assistant Professor Steam Turbines and Diesel
French, David M., M.S., Third Assistant Engineer, Assistant Professor Heat Transfer
San Martin, Joseph, B.S., Third Assistant Engineer, Assistant Professor Naval Architecture and Nuclear Propulsion
Tormollan, F. C., M.S., Head, Department of Marine Engineering, Associate Professor

DEPARTMENT OF NAVAL SCIENCE

Hewett, LT H. J., Jr., LT USN, Head of Department of Naval Science

To obtain further information, address all inquiries directly to:

Registrar
Texas A&M University
College Station, Texas 77843

## UNITED STATES MERCHANT MARINE ACADEMY
KINGS POINT, NEW YORK

The Academy's 39 buildings and marine facilities occupy 65 acres on the north shore of Long Island overlooking Long Island Sound, and include academic buildings, resident halls, shops and laboratories. In addition, the Academy operates miscellaneous small training craft on Long Island Sound.

The Academy offers a four-year undergraduate program of study which leads to the degree of Bachelor of Science, a Merchant Marine license as Third Mate or Third Assistant Engineer, and a Commission as an Ensign in the United States Naval Reserve. Three professional curriculums are offered: Nautical Science for the preparation of deck officers, Marine Engineering for the preparation of engineering officers and a combination of both, called a Dual License Curriculum. Approximately one-third of each curriculum embraces general education courses. Courses in oceanography are available as part of an elective program.

As part of the four-year program, midshipmen are assigned to merchant vessels for practical experience in the operation of ships. They spend a total of ten months at sea serving aboard American flag vessels on various trade routes. In addition to their shipboard duties they are required to complete a written project which is submitted to the Academy for evaluation and grading.

The following courses are offered in conjunction with the above programs (the credits are in quarter hours):

DEPARTMENT OF NAUTICAL SCIENCE

| | | |
|---|---|---|
| D 121 | Seamanship | 2 |
| D 122 | Seamanship | 2 |
| D 423 | Seamanship | 3 |
| D 141 | Navigation | 3.5 |
| D 142 | Navigation | 4 |
| D 443 | Navigation | 3 |
| D 103 | Safety of Life at Sea | 1.5 |
| D 204 | Safety of Life at Sea | 1.5 |
| D 406 | Safety of Life at Sea | 1.5 |
| D 232 | Cargo | 3 |
| D 233 | Cargo | 3 |
| D 261 | Naval Architecture | 3 |
| D 362 | Naval Architecture | 3 |
| D 251 | Electronics | 3 |
| D 452 | Electronics | 3 |

| | | |
|---|---|---|
| D 481 | Meteorology | 3.5 |
| D 283-1 | Descriptive Oceanography I | 3 |
| D 283-2 | Descriptive Oceanography II | 3 |
| D 284-1 | Dynamic Oceanography I | 3 |
| D 284-2 | Dynamic Oceanography II | 3 |
| D 285 | Research Methods and Field Research in Oceanography | 4 |
| D 287 | Meteorology and Oceanography Seminar | 3 |

DEPARTMENT OF ENGINEERING

| | | |
|---|---|---|
| E 113 | Elements of Marine Engineering | 4.5 |
| E 114 | Elements of Marine Engineering | 3.5 |
| E 124 | Marine Machinery Repair | .75 |
| E 225 | Marine Machinery Repair | .75 |
| E 121 | Machine Shop | 1.5 |
| E 222 | Machine Shop | 1.5 |
| E 223 | Statics | 3 |
| E 234 | Dynamics | 4 |
| E 235 | Hydraulics | 3.5 |
| E 241 | Thermodynamics | 3 |
| E 342 | Thermodynamics | 3.75 |
| E 343 | Thermodynamics | 3.75 |
| E 203 | Engineering Graphics | 2 |
| E 204 | Engineering Graphics | 2 |
| E 268 | Computer Science | 3 |
| E 361 | Electrical Engineering | 3.75 |
| E 362 | Electrical Engineering | 3.75 |
| E 451 | Marine Engineering (Steam) | 3.75 |
| E 452 | Marine Engineering (Steam) | 3.75 |
| E 453 | Marine Engineering (Steam) | 3.75 |
| E 473 | Refrigeration and Air Conditioning | 3.75 |
| E 472 | Internal Combustion Engines | 3.75 |
| | Ocean Engineering | 3 |

DEPARTMENT OF MATHEMATICS AND SCIENCE

| | | |
|---|---|---|
| | Oceanographic Chemistry I | 3 |
| | Oceanographic Chemistry II | 3 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF NAUTICAL SCIENCE

Hurder, Captain W. R., USMS; (Marine License: Master); Professor and Head of Department.
Fiore, Commander A.E., USMS; M.S.; (Marine License: Chief Mate); Professor.
Pearson, Commander L., USMS; M.S.; (Marine License: Chief Mate); Professor.
May, Lieutenant Commander R. B., USMS; (Marine License: Second Mate); Associate Professor.
Menser, Lieutenant F. W., USMS; B.S.; (Marine License: Master); Assistant Professor.
Nazzaro, Lieutenant Commander P., USMS; M.A.; (Marine License: Master); Associate Professor.
O'Hara, Lieutenant Commander W. J., USMS; (Marine License: Third Mate); Associate Professor.
Roberts, W. M.; Ph.D.; Assistant Professor.

DEPARTMENT OF ENGINEERING

Carlson, Commander S. O., USMS; M.M.E.; (Marine License: Second Engineer; Professional Engineer (New York) License); Professor
Drucker, Commander J. H., USMS; M.E., M.S.; (Marine License: First Engineer; Professional Engineer (new York and New Jersey) License); Professor
Gross, Commander M.J., USMS; M.M.E.; (Marine License: Chief Engineer; Professional Engineer (New York) License); Professor and Assistant Head of Department
Hirschkowitz, Commander M.W., USMS; M.M.E.; (Marine License: Chief Engineer; Atomic Energy License: Reactor Operator; Professional (New York) License); Professor
Hubert, Commander C.I., USMS; M.S.E.E.; (Professional Engineer (New York) License); Professor
McCready, Captain L.S., USMS; M.M.E.; (Marine License: First Engineer, Steam and Motor; Atomic Energy License: Sr. Reactor Operator; Professional Engineer (New York) License); Professor and Head of Department
Sandberg, Commander C.W., USMS; M.S.; (Marine License: First Engineer; Atomic Energy License: Reactor Operator); Professor
Travis, Captain H.O., Jr., USMS; M.S.; (Marine License: Chief Engineer; Professional Engineer (New York) License); Professor
Armstrong, Lieutenant Commander W.J., USMS; (Marine License: First Engineer); Associate Professor
Barnes, Lieutenant Commander G.H., USMS; B.S.; (Marine License: First Engineer); Associate Professor
Ferenczy, Lieutenant Commander E.D., USMS; M.S.; (Marine License : Chief Engineer); Associate Professor
Kirby, Lieutenant Commander H.M., USMS; M.A.; Associate Professor
Paquette, Lieutenant Commander D.R., USMS; M.S.; (Marine License : Third Engineer; Professional Engineer (New York) License); Associate Professor
Schuler, Lieutenant Commander F.X., USMS; B.S.; (Marine License: Second Engineer); Associate Professor
Wells, Lieutenant Commander R.B., USMS; B.S.; (Marine License: Chief Engineer); Associate Professor
Kane, Lieutenant L.B., USMS; B.M.E.; (Marine License: Third Officer); Assistant Professor
Kingsley, Lieutenant G.D., USMS; (Marine License: Chief Engineer); Assistant Professor
Madden, Lieutenant R.T., USMS; M.S.; (License: Chief Engineer); Assistant Professor
McDonald, Lieutenant W.H., USMS; M.S.; Assistant Professor
Panuska, Lieutenant R.C., USMS; A.B.; Assistant Professor
Reynolds, Lieutenant F.X., USMS; M.S.M.E.; (Marine License: Second Engineer; Professional Engineer (New York) License); Assistant Professor
Giaquinto, Lieutenant (junior grade) J.A., USMS; Instructor
Antell, Lieutenant (junior grade) J., USMS; Laboratory Instructor
Malinoski, Lieutenant (junior grade) L.A., USMS; Laboratory Instructor
Maroney, Lieutenant (junior grade) N.J., USMS; (License: Journeyman Electrician); Laboratory Instructor
Newman, Lieutenant (junior grade) H.J., USMS; (License: Certified Welder); Laboratory Instructor

Sferazo, Lieutenant (junior grade) L. J., USMS; (License: Certified Welder); Laboratory Instructor.

DEPARTMENT OF MATHEMATICS AND SCIENCE

Dittrick, Captain J. M., USMS; M.S.; Professor and Head of Department.
Beim, Lieutenant H. J., USMS; Ph.D.; Assistant Professor.
Weiss, Lieutenant E., USMS; M.S.; Assistant Professor.

To obtain further information, address all inquiries directly to:

Academic Dean
United States Merchant Marine Academy
Kings Point, New York 11024

# *CURRICULA FOR*

# *MARINE TECHNICIANS*

## ANNE ARUNDEL COMMUNITY COLLEGE
### ARNOLD, MARYLAND

The college took occupancy of its new campus in 1967 which included new lab facilities for physics, chemistry and biology. An ocean engineering lab has been built and includes: a high pressure testing facility, a hydrophone testing tank and a shallow water wave generating tank. Additional college facilities that are available to the Ocean Engineering Technology program include a machine shop, structures laboratory, electronic data processing center, and electronics laboratory. Field experience in ocean engineering technology includes six days' instruction on the catamaran R/V RIDGELY WARFIELD operated by the Chesapeake Bay Institute. Two new ocean labs totaling 2000 square feet are presently being designed.

The college offers the Associate in Arts degree in Ocean Engineering Technology with the student electing to specialize in either the field of mechanical engineering technology or electrical engineering technology. Requirements for the degree include 24 hours general education, four hours physical education, and 43 hours technical education.

In conjunction with the above degree, the following courses are required:

| | | |
|---|---|---|
| OET 111 | General Oceanography | 3 |
| OET 113 | Ocean Technology & Water Chemistry | 5 |
| OET 211 | Marine Instrumentation | 4 |
| OET 212 | Ocean Mechanics | 4 |
| OET 214 | Marine Science Technology Seminar | 1 |
| Eng 111 | Composition & Introduction to Literature I | 3 |
| Eng 112 | Composition & Introduction to Literature II | 3 |
| Phys 111 | Fundamentals of Physics I | 4 |
| Phys 112 | Fundamentals of Physics II | 4 |
| Math 121 | Algebra and Trigonometry | 4 |
| Math 122 | Math with Calculus I | 4 |
| Math 123 | Math with Calculus II | 3 |
| EDP 241 | FORTRAN | 2 |
| PE | Physical Activities | 4 |

ELECTRICAL OPTION

| | | |
|---|---|---|
| EET 111 | Fundamentals of Electronics | 5 |
| EET 112 | Circuit Analysis | 5 |
| EET 211 | Communications Circuits | 5 |
| EET 222 | Control Circuits & Systems | 4 |
| EET 232 | Electronic Design & Fabrication | 3 |

MECHANICAL OPTION

| | | |
|---|---|---|
| MET 111 | Engineering Graphics I | 3 |
| MET 112 | Engineering Graphics II | 3 |
| MET 121 | Manufacturing Processes | 3 |
| MET 122 | Introduction to Engineering Materials | 3 |
| MET 231 | Applied Statics | 2 |
| RW 111 | Technical Report Writing | 2 |
| EET 291 | Electricity I | 3 |
| EET 292 | Electricity II | 4 |

Instructional staff for the technical courses listed above consists of the following:

Bowers, Richard H., M.S.M.E., Assistant Professor, Engineering
Butler, Thomas W., Ph.D., Assistant Professor (part-time), Mechanical Engineering Technology
Liimatta, Peter E., M.Ed., Assistant Professor, Electrical Engineering Technology
Miller, Charles G., B.S.E.E., Instructor, Electrical Engineering Technology
Smith, Robert J., B.S.E.E., Assistant Professor, Electrical Engineering Technology
Somers, George W., M.S.M.E., Assistant Professor, Mechanical Engineering Technology
Stibolt, Kenneth A., M.S.M.E., Assistant Professor, Ocean Engineering Technology
Sullivan, Edmund J., M.S.M.E., Assistant Professor (part-time), Mechanical Engineering Technology
Theisz, Jr., Gordon F., M.E.E., Assistant Professor, Electrical Engineering Technology
West, Jr., Thomas F., B.S.M.E., Instructor (part-time), Mechanical Engineering Technology

To obtain further information, address all inquiries directly to:

Kenneth Stibolt
Assistant Professor, Director
Ocean Engineering Technology
Anne Arundel Community College
Arnold, Maryland 21012

## CAPE FEAR TECHNICAL INSTITUTE
### WILMINGTON, NORTH CAROLINA

Facilities at the Cape Fear Technical Institute consist of three well equipped laboratories for marine biology, chemistry, and physics, and classroom area for instruction and demonstrations.

Operations at sea, in the Institute's own training ship, include practical seamanship, navigation fishing operations, and necessary experiments, collection, and processing of the data in connection with marine biology and oceanography.

The school ship ADVANCE II which has a length of 185 feet, a beam of 33 feet, and a draft of 11 feet, carries a 26-foot motor launch for oceanographic and hydrographic work and a Coast Guard approved whale boat for rescue training. The vessel's range is 2,500 miles at 15 knots. Accommodations for up to 70 students and instructors, in addition to the crew, are available. A small machine shop, pipe fitters shop, and electricians shop are also aboard. It is equipped with an Alden Facsimile capable of receiving weather and oceanographic information plus a program calculator.

Navigational equipment on the ship includes: two radar sets, 48 mile range; three PPI scopes; four Loral systems including A&C; one automatic direction finder; one portable direction finder; two marine radiotelephones; four radio receivers; one subsignal sounding machine 860 fathoms maximum depth (300 fathoms white line recorder); one master gyro system with repeater peloruses. The vessel is fully equipped for both oceanographic and biological research.

Cape Fear Technical Institute also operates the MV UNDAUNTED, 145-foot length, similarly equipped, and the DALLAS HERRING, 110 foot length, an oceangoing tug presently being converted for oceanographic and biological research.

In addition, Cape Fear Technical Institute maintains a sizable fleet of small boats



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for shore and estuary research.

Cape Fear Technical Institute has an ongoing research program in cooperation with the National Science Foundation, National Bureau of Commercial Fisheries, NASA, and the Naval Oceanographic Office. This program provides a base of shipboard experience for all Marine Technology students.

The Institute offers the Associate of Applied Science Degree in Marine Technology (shipboard orientation) and in Marine Laboratory Science (shoreside orientation).

The following courses are offered in conjunction with the above programs:

Navigation
Marine Engineering
Marine Biology
Cartography
Oceanography
Mathematics
Statistics
Physics
Chemistry
Electronics
Fisheries
Fishing Operations
Ship Experience
General Biology
Microbiology
Zoology
Geology
Meteorology
Ecology
Aquaria
Oceanographic Instrumentation
Oceanographic Techniques
Scuba Diving
Small Boat Handling and Repair
Photography
Communicative Skills
Technical Writing

The instructional staff for the courses listed above consists of the following:

Buck, Dale, Oceanography
Finnan, Frank, Marine Engineering
Foss, Edward, Chairman of Instructional Staff
Gladding, Thomas, Navigation and Electronics
Hauser, James, Geology
Jordan, Captain Arthur W., Director of Sea Grants and Marine Operations
Mangum, William, Mathematics
Martin, James, Marine Biology
Remington, George, Electronics and Physics
Rhodes, Thomas, Marine Biology
Stanton, Mike, Fisheries

To obtain further information, address all inquiries directly to:

CAPT Arthur W. Jordan
Director of Sea Grants and
Marine Operations
Cape Fear Technical Institute
Wilmington, North Carolina 28401

## CLATSOP COMMUNITY COLLEGE
### ASTORIA, OREGON

Clatsop Community College is completing its third year of the oceanographic technicians program initiated in 1968 under the National Science Foundation Sea Grant Project in cooperation with Oregon State University. The geographical location of Clatsop Community College, 12 miles from the Pacific Ocean on the Columbia River, is most advantageous for providing the needed resources for successfully conducting the program. The Columbia River is extremely well suited for preliminary training in seamanship, commercial fishing, and oceanographic techniques. The area provides sheltered water for training in techniques of handling instruments, plankton tows, water sampling, salinity tests, etc. Proximity to the Pacific Ocean is an important asset for training of the more advanced students.

The College, by virtue of its programs, to date, in marine technology training, has acquired much of the needed facilities and experience. An additional factor which enhances its ability to offer the proposed program is the opportunity of institutional cooperation with local and regional government and private organizations. Such organizations include the O.S.U. Astoria Seafoods Laboratory, the Otter trawl Commission of Oregon, Bio Products, the Fish Commission of Oregon, the Oregon State Game Commission and Oregon State University.

In order to provide adequate field-training in this field, Clatsop Community College has acquired a used, 50-foot, steel hulled, twin screw, diesel powered vessel which is USCG inspected and approved for passenger service. This vessel will be equipped for Oceanographic Research Training, Navigation, Boat Handling, General Pilotage and teaching Commercial Fishing Techniques.

The College offers Associate Degrees in Science in Oceanographic Technology, Marine Technology, and Commercial Fishing Technology. All students are required to satisfactorily complete a minimum of 90 term hours of approved course work with a minimum grade point average of 2.00. A minimum of eighteen term hours of general education courses and three term hours of personal health are required. The student must be in attendance at Clatsop Community College at least two terms including the last term before the Associate in Science degree is awarded, and must have completed 24 term hours at Clatsop Community College. A major emphasis is placed both on classroom and on sea experiences so that students will develop proficiency in the many diversified skills required in maritime occupations.

This Community College offers to the student either a two-year vocational degree or two years of college transfer credit. This curricular organization provides the student with diversity of occupational and academic goals which can be selected according to individual abilities, interests, and motivation.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| 3.500 | Seamanship I | 4 |
| 3.502 | Seamanship II | 4 |
| 3.504 | Seamanship III | 4 |
| 4.522 | Basic Commercial Fishing I | |
| 4.523 | Basic Commercial Fishing II | |
| 5.524 | Basic Commercial Fishing III | |
| 4.152 | Welding Fundamentals I | 2 |
| 4.155 | Welding Fundamentals II | 2 |
| 3.620 | Navigation | 3 |
| 3.510 | Electrical Equipement | 2 |
| 3.512 | Marine Biology I | 4 |
| 3.514 | Marine Biology II | 4 |
| 3.412 | Oceanographic Instruments | |
| 3.321 | Hydraulics and Pneumatics | 3 |

| | | |
|---|---|---|
| 4.300 | Practical Physics I | 4 |
| 4.301 | Practical Physics II | 4 |

TECHNICAL COURSES FOR MARINE TECHNOLOGY MAJOR

| | | |
|---|---|---|
| 6.150 | Fundamentals of Electronics I | 4 |
| 6.155 | Fundamentals of Electronics II | 4 |
| 6.160 | Fundamentals of Electronics III | 4 |
| 3.525 | Adv. Commercial Fishing Techniques | 4 |
| 3.524 | Maintenance and Repair | 3 |
| 6.251 | F.C.C. Radio and Telephone License Prep. | 3 |

The instructional staff for the courses listed above consists of the following:

Bergeron, Daniel J., M.S., Instructor of Oceanography
Elsbree, J.S., Captain (Master-Oceans-Unlimited License), Instructor of Marine Technology
Hargis, Jackson B., Ed.D., Coordinator, Sea Grant Program and Department of Maritime Sciences

To obtain further information, address all inquiries directly to:

Mr. Earl Craven
Dean of Students
Clatsop Community College
Astoria, Oregon 97103

## DEL MAR COLLEGE
### CORPUS CHRISTI, TEXAS

The College offers a curriculum in marine science technology including the freshman and sophomore years. The program is designed so that students upon attainment of the Associate (two-year) degree may at their option either enter industry ready for immdeiate useful employment or transfer to a senior institution and pursue a bachelor's degree. The program is supported by the National Sea Grant Program through Texas A&M University. The curriculum was initiated in 1969 and has use of well equipped general biology, geology, chemistry and physics laboratories. The College also has a marine instrument laboratory with an instrumented two dimensional wave tank and a large marine chemical-physical laboratory. Students also do summer studies in laboratories of area non-profit participating agencies. Training aboard the 50-foot training vessel T/V MARINER and the 55-foot water pollution vessel R/V EXCELLENCE is coordinated through the Sea Grant Office of Texas A&M University.

The Associate in Applied Science is offered by the Department of Marine Science Technology. The marine science technology curriculum is designed with flexibility to suit the student's preferences and aptitudes. A student may minor in the physical sciences or engineering technology.

The degree requires a minimum of 75 hours of approved courses distributed as indicated.

| | |
|---|---|
| Marine Science Technology | 29 hours |
| Mathematics | 9 hours |
| English (Must include Eng 304/317) | 6-9 hours |
| History and Government (Must include Govt 610a) | 3-12 hours |
| Science and/or Engineering Technology (Must include EET 403) | 28 hours |

An approved degree plan must be submitted before the second semester in residence. Although the students have options in supporting courses, all students must take at least one course in electronic engineering technology.

The following courses are offered in conjunction with the above program:

UNDERGRADUATE COURSES

DEPARTMENT OF MARINE SCIENCE TECHNOLOGY

| | | |
|---|---|---|
| MST 401 | Introduction to the Marine Environment | 4 |
| MST 402 | Physical-Chemical Oceanography | 4 |
| MST 405 | Biological-Geological Oceanography | 4 |
| MST 806a | Marine Laboratory I | 4 |
| MST 806b | Marine Laboratory II | 4 |
| MST 310 | Underwater Acoustics | 3 |
| MST 311 | Marine Laboratory III | 3 |
| MST 413 | Marine Science Problems | 4 |
| MST 414 | Marine Science Instrumentation | 4 |
| MST 116 | Marine Science Seminar | 1 |

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF MARINE SCIENCE TECHNOLOGY

Lambertson, T. J., P.E., M.S., Assistant Professor of Marine Science Technology
O'Donnell, J. F., Ph.D., Assistant Professor of Marine Science Technology

DEPARTMENT OF BIOLOGY

White, J. M., Ph.D., Professor of Biology

DEPARTMENT OF ENGINEERING TECHNOLOGY

Williams, R. J., P.E., Ph.D., Professor of Engineering Technology

DEPARTMENT OF GEOLOGY

Thorpe, M. S., M.S., Instructor of Geology

To obtain further information, address all inquiries directly to:

Registrar
Del Mar College
Corpus Christi, Texas 78404

## FULLERTON JUNIOR COLLEGE
### FULLERTON, CALIFORNIA

Standard laboratory facilities and classrooms, ship time donated to us by local institutions and government agencies, and visits to regional industrial facilities provide instructional situations.

The Fullerton Junior College program in Oceanographic Technician training is designed to prepare entry-level technicians in marine oriented operations. The curriculum grants the Associate in Arts degree, enabling students to transfer to senior institutions to pursue an academic rather than vocational-technical goal.

Basic oceanographic science and associated subjects are provided in campus facilities. Special equipment, research

situations, ship management and "hands-on" training require off-campus opportunities, frequently donated facilities.

In-year and summer experiences with on-board or on-shore work programs provide the student with actual on-the-job conditions and credit for up to eight units.

Continuous evaluation of student performances and objectives provides opportunity for limited specialty training in the physical or biological techniques in the marine sciences.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| 1 | General Biology | 5 |
| 25 | Marine Biology | 3 |
| 49A | Life Sciences Independent Study | 1 |
| 49B | Life Sciences Independent Study | 1 |
| 49C | Life Sciences Independent Study | 1 |
| 30 | Introduction to Ocean Science | 3 |
| 32A | Oceanographic Materials and Instruments | 3 |
| 32B | Oceanographic Materials and Instruments | 3 |
| 33 | Navigation-Drafting | 4 |
| 54 | Cooperative Oceanographic Technology | 2-8 |
| A | Trigonometry and Elementary Functions | 5 |
| 1 | Physical Geology | 3 |
| 1L | Physical Geology Laboratory | 1 |
| 3 | Introduction to Chemistry | 5 |
| 2A | College Physics | 3 |
| 2B | College Physics | 3 |
| 3A | College Physics Laboratory | 1 |
| 3B | College Physics Laboratory | 1 |
| 1A | General Zoology | 5 |
| 1B | General Zoology | 5 |
| 5A | Principles of Biology | 4 |
| 5B | Principles of Biology | 4 |
| 81A | Technical Mathematics | 3 |
| 81B | Technical Mathematics | |
| 10 | Elementary Physics | 4 |

The instructional staff for the courses listed above consists of the following:

Brown, Martin D., Chairman, Division of Life Sciences
Craig, Howard, Coordinator and Instructor
Leyman, Larry, Instructor

To obtain further information, address all inquiries directly to:

Howard Craig, Coordinator
Oceanographic Technology Program
Fullerton Junior College
321 East Chapman Avenue
Fullerton, California 92634

## GULF COAST JUNIOR COLLEGE
### PANAMA CITY, FLORIDA

Special facilities are housed in the Division of Mathematics and Science. A 12-acre site has recently been acquired with waterfront on a salt water bay with deep and shallow areas as well as an island. The College also borders a large bay and has two fresh water lakes on the campus. Two laboratories are available to the Biology Department, but only one is used for Marine Biology. Plankton nets, beach nets, and trawls are availavailable for collecting of specimen.

The following degrees are offered:

1. Associate of Applied Science. This is generally a terminal two-year degree. Students have two options in the sophomore year: the Physical Option or the Biological Option. Students are encouraged to obtain practical field experience through internship courses for credit.

2. Associate of Arts in Pre-Oceanography. This program is intended to be preparation for transfer to and completion of a four-year program in oceanography. The student is required to take Chemistry (103-104), Physics (201-202), Algebra (MS 105), and Trigonometry (MS 110). It is recommended that he take Biology electives.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| BY 207 | Marine Biology | 2 |
| OY 200 | Ecology of the Sea | 4 |
| OY 202 | Marine Laboratory Techniques | 3 |
| PSLS 113* | Physical Geology | 3 |
| PSLS 143 | Fundamentals of Oceanography | 3 |
| PSLS 163* | Basic Physics | 3 |
| EG 101 | Engineering Drawing | 3 |
| EG 112 | D.C. Circuits | 4 |
| EG 243* | Mechanics | 3 |
| EG 241* | Surveying | 4 |
| EG 114* | A.C. Circuits | 4 |
| EG 213* | Electronic Problems | 3 |

*Required in the Physical Option.

The instructional staff for the courses listed above consists of the following:

MATH-SCIENCE DIVISION

Brown, W. Jow, M.A.T., Associate Professor of Biology
Everett, Hayes L., M.Ed., Associate Professor of Physical Science
Masters, Dale, Assistant Professor of Biology
Tinney, Robert Ray, Chairman, Math-Science Division
Traweek, James C., M.S., Assistant Professor of Chemistry

TECHNICAL AND SPECIALIZED DIVISION

Haseltine, A.B., Assistant Professor of Drafting Design
Jones, Robert C., Assistant Professor of Electronics
Wigfall, George, Assistant Professor of Drafting Design

To obtain further information, address all inquiries directly to:

For the A.A.S. degree

Lester Morley
Dean of Technical and Specialized Education
Gulf Coast Junior College
Panama City, Florida 32401

For the A.A. in Pre-Oceanography degree

Robert R. Tinney, Chairman
Division of Mathematics-Science
Gulf Coast Junior College
Panama City, Florida 32401

## HIGHLINE COMMUNITY COLLEGE
### MIDWAY, WASHINGTON

The facilities on the campus are located

in the Science and Engineering buildings. Classrooms and laboratories contain modern equipment. The college also maintains laboratory and dock facilities on Puget Sound for underwater training. These facilities are equipped to provide training in all types and phases of diving.

The award of Certificate in Undersea Technology is offered.

The following courses are offered in conjunction with the above award:

DIVING

| | | |
|---|---|---|
| 71 | Diving Fundamentals | 3 |
| 72 | Diving Fundamentals | 5 |
| 73 | Diving Fundamentals | 5 |
| 74 | Diving Applications | 5 |
| 81 | Advanced Diving | 7 |
| 82 | Advanced Diving | 7 |
| 83 | Advanced Diving | 7 |

INDUSTRIAL TECHNOLOGY

| | | |
|---|---|---|
| 51 | Welding | 3-6 |
| 52 | Welding | 3-6 |
| 53 | Welding | 3-6 |
| 65 | Basic Electronics | 3 |
| 95 | Blueprint Reading | 3 |

ENGINEERING

| | | |
|---|---|---|
| 83 | Construction Materials | 4 |
| 100 | Engineering Fundamentals | 3 |
| 110 | Materials and Processes of Industry | 4 |
| 111 | Materials and Processes of Industry | 4 |
| 121 | Surveying | 3 |

MATHEMATICS

| | | |
|---|---|---|
| 71 | Technical Mathematics | 3 |
| 72 | Technical Mathematics | 3 |

OCEANOGRAPHY

| | | |
|---|---|---|
| 100 | Survey of Oceanography | 5 |

PHYSICAL EDUCATION

| | | |
|---|---|---|
| 123 | Watermanship | 1 |
| 124 | Survival | 1 |

ENGLISH

| | | |
|---|---|---|
| 71 | Communications | 3 |
| 72 | Communications | 3 |
| 73 | Communications | 3 |

The instructional staff for the courses listed above consists of the following:

DIVISION OF APPLIED SCIENCES

Elliott, Raymond S., Instructor, Welding
Hagen, Trond, B.S., Instructor Civil Engineering
Powell, Roger B., M.A., Instructor Engineering Technology
Sell, Phillip C., M.E.D., Department Chairman, Engineering Technology
Talbot, Maurice, Instructor, Undersea Technology
Williams, Peter A., Instructor Undersea Technology

DIVISION OF NATURAL SCIENCES

Chapman, D. Duane, Ph.D., Instructor, Oceanography
Knutson, Kenneth K., M.A.T., Division Chairman, Natural Sciences
Neish, Gerald L., M.B.S., Instructor, Electronics
Zemgalis, Elmar, M.A., Instructor, Mathematics

To obtain further information, address all inquiries directly to:

Mr. Peter Williams
Diving Instructor
Highline Community College
Midway, Washington 98031

Mr. James C. Scott
Associate Dean, Occupational Programs
Highline Community College
Midway, Washington 98031

## COLLEGE OF MARIN
### KENTFIELD, CALIFORNIA

As part of its Marine Technology Program the College has a marine laboratory at Bolinas, California. The station is equipped with a circulating sea water laboratory and student living quarters. Vast mudflats and rich intertidal reefs provide excellent locales for biological studies. Two Boston Whalers and a 32-foot diesel oceanographic ship provide facilities for making nearshore water and sediment measurements. Cooperative in-service training is provided by oceanographic organizations in the San Francisco Bay Area.

The degree of A.S. in Marine Technology is offered. Students are required to take 48 total hours in a fixed curriculum which emphasizes electronics and instrumentation. A biological option is available to students not desiring an electronic emphasis. Students may also take the marine courses for general education and for transfer majors.

The following courses are offered in conjunction with the above programs:

1st SEMESTER

| | | |
|---|---|---|
| Geol 15 | General Oceanography | 3 |
| Math 53 | Technical Mathematics | 3 |
| Elec 61 | Introductory Electronics | 4 |
| Engr 51AB | Drafting | 2 |
| | English or Communications | 3 |
| | Physical Education | .5 |

2nd SEMESTER

| | | |
|---|---|---|
| Biol 10 | General Biology | 3 |
| C.S. 50 | Computer Science | 3 |
| Elec 62 | Introductory Electronics | 4 |
| AmSt 1A | History | 3 |
| | Electives | 2 |
| | Physical Education | .5 |

SUMMER - MARINE EXPERIENCE

3rd SEMESTER

| | | |
|---|---|---|
| Chem 11 | General Introductory Chemistry | 4 |
| Phys 55 | General Instrumentation | 4 |
| Geol 1A | Introduction to Physical Geology | 4 |
| | English or Communications | 3 |
| | Physical Education | .5 |

4th SEMESTER

| | | |
|---|---|---|
| MMT 59 | Machine Processes | 3 |
| Phys 50 | Marine Instrumentation | 2 |
| AmSt 1B | Government | 3 |
| | Electives | 7 |
| | Physical Education | .5 |

SUGGESTED ELECTIVES

| | |
|---|---|
| Biol 20A | Marine Biology |
| Biol 21AB | Marine Ecology |
| Chem 71 | Chemistry Instrumentations |
| Elec 60A | Fabrications |
| Geol 56 | Mineralogy |
| Art 48 | Photography |

The instructional staff for the courses listed above consists of the following:

Chan, Gordon L., Ph.D., Director of Marine Technology Program
Bezirjian, Onnig H., Ph.D., Chemistry Instrumentation
Greenfield, Donald R., M.A., Machine and Metals
Hansen, Michael P., B.S., Computer Data Technology
Howe, William W., M.S., Engineering Survey-Graphics
Johnson, Thomas C., M.A., Marine Photography
Martin, Donald W., M.A., Physics Instrumentation
Miller, Kenneth J., M.S., Mineralogy
Molina, Alfonso, M.A., Marine Biology, Director of the Bolinas Marine Station
O'Kane, John, M.S., Oceanography
Peterson, Robert, M.S., Physics Instrumentation
Ridge, Russell M., M.A., Biology
Staley, James C., M.S., Electronics
Stryker, Jay, M.S., Electronics

To obtain further information, address all inquiries directly to:

Dr. Gordon Chan
Director of Marine Technology
College of Marin
Kentfield, California 94904

## MIAMI-DADE JUNIOR COLLEGE
MIAMI, FLORIDA

The present temporary facilities on the Miami River (5,000 square feet) provide the focal point for all Marine Science Technology activity. This facility contains a marine reference center, classroom and laboratory areas, shop and staging area, diving locker and instrument room. Besides the indoor facility, the grounds contain davits to handle our two small boats (22 feet), dockage for our runabouts and 45-foot vessel, and a diving and instrument training tank.

The 45-foot vessel is provided with major electronic equipment, wet laboratory, dry laboratory and considerable deck space aft. If is used to support a coordianated lecture/laboratory/field "hands-on" approach.

The diving/instrument tank provides a means of providing initial training on site independent of weather and vessel schedules. It is primarily used to support the diving program in underwater photography, welding, and other work tasks.

This institution offers three two-year curricula in Marine Science Technology which lead to an Associate in Science degree. These programs are: Marine Survey Technology, Marine Engineering Technology, and Marine Electronics Technology.

The Marine Survey Technician would assume responsibilities for the support of engineering and scientific efforts to acquire data at sea. He would be trained in the use of common oceanographic instruments (such as salinity, temperature, and depth recorders) and processing of the data acquired. The work may encompass estuary and coastal areas as well as the open ocean.

The Marine Engineering Technician would assume responsibility for the support of engineering and scientific efforts to perform work on deck and below the water. He would be able to assist in the design, fabrication, installation, and maintenance of equipment in the ocean environment. This person will be trained in SCUBA diving and will perform many of his work tasks such as welding underwater.

The Marine Electronics Technician would assume responsibility for support of engineering and scientific efforts to provide electronic-mechanical instrumentation for use at sea. He would be able to assist design and provide fabrication, operation, and maintenance capability for these instruments.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| GEL 110 | Introduction to Oceanography | 3 |
| MST 111 | Introduction Oceanography I - Laboratory | 1 |
| MST 112 | Applied Oceanography | 3 |
| MST 115 | Seamanship | 3 |
| MST 118 | Marine Electricity | 3 |
| MST 120 | Marine Engineering Practices I | 3 |
| MST 121 | Marine Engineering Practices II | 3 |
| MST 198 | Operational Diving | 2 |
| MST 200 | Underwater Operations I | 3 |
| MST 201 | Marine Surface Operations | 3 |
| MST 202 | Underwater Operations II | 3 |
| MST 204 | Advanced Diving | 3 |
| MST 210 | Ocean Measurements I | 3 |
| MST 211 | Ocean Measurements II | 3 |
| MST 298 | Internship or Field Problems | 3 |
| MST 299 | Internship or Field Problems | 3 |
| ELE 280 | Survey of Marine Electronic Equipment | |

The College also offers a pre-Ocean Engineering program which prepares the student for entry into the junior year of Ocean Engineering at Florida Atlantic University. Completion of a four-year program in this area of study will prepare the student for positions as a junior engineer in industry, and for private or government laboratories engaged in engineering work in the ocean and its environment. The student should consult with an Academic Advisor regarding details of this program.

The instructional staff for the courses listed above consists of the following:

DEPARTMENT OF MARINE TECHNOLOGY

Benson, Richard C., B.S., Chairman and Assistant Professor of Marine Science Technology
Cawthon, Stephen, Instructor/Technician
Kern, Ferderick, B.S., Instructor/Diving Officer

DEPARTMENT OF CHEMISTRY AND EARTH SCIENCE

Drobner, Robert H., M.A., Department Chairman, North Campus, and Professor of Earth Science and Chemistry
Wicks, Loren D., M.A., Department Chairman, South Campus, and Associate Professor of Earth Science

DIVISION OF TECHNICAL AND VOCATIONAL TRAINING (NORTH CAMPUS)

Mehallis, George, Ph.D., Division Director and Professor

DEPARTMENT OF ELECTRONICS (NORTH CAMPUS)

Powell, Roy, M.Ed., Department Chairman, and Assistant Professor of Instrumentation, Electronic and Mechanical Technology

DEPARTMENT OF CIVIL ENGINEERING

Davidson, A. H., Jr., M.S.C.E., Department Chairman, North Campus, and Professor of Engineering and Civil Engineering

To obtain further information, address all inquiries directly to:

Richard C. Benson
Chairman, Marine Technology
Miami-Dade Junior College
1090 N.W. North River Drive
Miami, Florida 33136

## ORANGE COAST COLLEGE
### COSTA MESA, CALIFORNIA

The campus is four miles from the ocean, inland of the City of Newport Beach, some 40 miles southwest of Los Angeles. Marine science facilities at Orange Coast College include a 9,000 gallon closed refrigerated marine aquarium system, separate refrigerated aquaria, water-immersion microscopes and related optical equipment, access through remote terminals to an IBM 365/50 located on the campus for data processing, portable electronic calculators for field use, portable electronic sensing equipment for dissolved oxygen, temperature, salinity, pH, conductivity, etc.; biological sampling equipment such as bottom dredges, plankton nets and open water trawls; a portable marine laboratory accommodating ten students and capable of extended on-site work near an intertidal area; two 16-foot Boston Whalers for near-shore investigations and two laboratories designated for marine courses on campus. Although the College does not own a deep-water oceanographic research vessel, it may purchase time on a suitable ship as requirements dictate.

The A.A. degree in Marine Technology is offered. The two-year curriculum provides options for concentration in the biological or physical science area, or in electronics. The program is not designed to prepare students for transfer to a four-year college. Coursework consists of marine science core courses, support courses in physics and mathematics, and general education courses required for the A.A. degree.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| MS 1 | Marine Resources | 3 |
| MS 2 | Introduction to Marine Science | 3 |
| MS 3 | Marine Biology | 3 |
| MS 4 | The Marine Environment | 3 |
| ES 2A-B | Instrumentation and Analysis | 3 |
| ES 3 | Resources and Man | 3 |
| ES 4 | Conservation and Management of Aquatic Resources | 3 |
| Phys 47 | Technical Physics | 4 |
| Phys 48 | Technical Physics II | 4 |
| Bio 4 | Field Ecology | 3 |
| Bio 5 | Field Zoology | 3 |
| Geo 2 | Introductory Geology | 3 |
| Math 40 | Technical Mathematics | 3 |
| Math 45 | Intermediate Technical Mathematics | 3 |
| CS 100 | Introduction to Data Processing | 1 |
| InA 32 | Drafting | 2 |
| InA 33 | Machine Shop | 3 |
| InA 34 | Electronics | 3 |
| ET 51A | Basic Electronics | 6 |
| ET 51B | Basic Electronics | 6 |
| ET 52A | Electronic Systems I | 4 |
| ET 52B | Electronic Systems II | 4 |
| ET 70 | Electronic Construction Technology | 2 |
| PE 27A-D | Lifesaving | .5 |
| PE 29A-D | Skin Diving | .5 |
| PE 30A-D | SCUBA Techniques | .5 |
| Eng 2 | Technical Writing | 3 |

The instructional staff for the courses listed above consists of the following:

DIVISION OF BIOLOGICAL AND AGRICULTURAL SCIENCES

Smith, L.M., M.A., Chairman and Professor of Biology

DEPARTMENT OF MARINE TECHNOLOGY

Garrison, Tom S., M.A., Instructor in Marine Biology
Valencia, Shirley M., M.S., Instructor in Marine Science

CURRICULUM ADVISER

Follansbee, Lewis A., Ph.D., Director of Environmental Studies Center, Professor of Marine Science

To obtain further information, address all inquiries directly to:

Mr. Tom S. Garrison, Coordinator
Department of Marine Sciences
Orange Coast College
2701 Fairview Road
Costa Mesa, California 92626

## PENINSULA COLLEGE
### PORT ANGELES, WASHINGTON

The fisheries building, completed in January, 1967 is an integrated unit comprised of one classroom, one lab-classroom, office for two instructors, an equipment room, museum and workshop. A large covered area on one side furnishes shelter for boats, nets and other large equipment. Located on the campus is a 16 x 20 foot hatchery building capable of raising 250,000 fish to the fry stage. Two 15-foot circular cement ponds outside the building are used to hold fish until ready to plant. A small fishing boat, rehabilitated

by the class, is also part of the equipment.

The degree of Associate of Applied Arts (Fisheries Certificate) is offered.

All students must receive passing grades in Fish 31, 41, 51, 33, 35, 45, 55, 43, 46, 54, 56, 70, 72, 73, 74, 80, 82 (Wildlife Management), 83, 90, 92, and GE 91 (Surveying).

In addition to the above courses each student must complete one each of the fall, winter, and spring offerings of Fisheries Equipments Hatchery Methods in any sequence, and have one year (or equivalent) of biological science. His college credits must total 90 credit hours.

The following courses are offered in conjunction with the above program: (Credits are in quarter hours.)

| | | |
|---|---|---|
| Chem 31 | Technical Chemistry | 3 |
| Chem 41 | Technical Chemistry | 3 |
| Chem 51 | Technical Chemistry | 3 |
| Fish 33 | Taxonomy of Fishes | 4 |
| Fish 35 | Hatchery Methods | 2 |
| Fish 45 | Hatchery Methods | 2 |
| Fish 55 | Hatchery Methods | 2 |
| Fish 43 | Life History of Fishes | 3 |
| Fish 46 | Technical Report Writing | 2 |
| Fish 56 | Technical Report Writing | 2 |
| Fish 54 | Population Studies | 3 |
| Fish 70 | Technical Trigonometry | 3 |
| Fish 72 | Fish Diseases | 3 |
| Fish 73 | Fish Farming | 4 |
| Fish 74 | Aquatic Environments | 3 |
| Fish 80 | Technical Statistics | 3 |
| Fish 90 | Technical Statistics | 3 |
| Fish 82 | Wildlife Management | 4 |
| Fish 83 | Commercial Fisheries | 4 |
| Fish 91 | Aquatic Insects | 4 |
| Fish 92 | Marine Invertebrates | 4 |
| Fish 95 | Microtechnique | 4 |
| Fish 96 | Study Collections | 2 |

The instructional staff for the courses listed above consists of the following:

FISHERIES DEPARTMENT

Grinols, Richard B, M.S., Fisheries Instructor
Mausolf, Robert G., B.S., Fisheries Instructor
Well, Donald R., B.S., Fisheries Instructor

To obtain further information, address all inquiries directly to:

Registrar
Peninsula College
Port Angeles, Washington 98362

## UNIVERSITY OF RHODE ISLAND
### KINGSTON, RHODE ISLAND

The Department of Fisheries and Marine Technology operates facilities both on and off the main campus at Kingston. Main operations are conducted from Wickford on Narragansett Bay where the training vessels are berthed. The facilities contain practical laboratories for training in Seamanship, Fishing Gear, Navigation, Electronic Aids (to navigation and fisheries), Engineering, and Electrical Technology. Two training vessels are available; the 47-foot GAIL ANN, specifically converted for fisheries training and completely equipped, with a Decca Navigator and Sonar, and capable of working all common fishing methods; and a 21-foot Romany Fisherman for in-shore training.

The Department offers the degree of Associate in Science (Commerical Fisheries). In order to obtain the degree, all students are required to complete 72 credits over a two-year period--51 in Fisheries and Marine Technology, 21 in General Education, Business and Economics.

The following courses are offered by the Department in conjunction with the above program:

| | | |
|---|---|---|
| 013 | Shipboard Work I | 1 |
| 014 | Shipboard Work II | 1 |
| 015 | Shipboard Work III | 1 |
| 118 | Introduction to Commercial Fisheries | 4 |
| 121 | Fishing Gear I | 3 |
| 122 | Fishing Gear II | 3 |
| 131 | Seamanship | 3 |
| 135 | Fisheries Meteorology | 1 |
| 141 | Marine Engineering Technology I | 4 |
| 142 | Marine Engineering Technology II | 4 |
| 151 | Fish Technology | 4 |
| 161 | Marine Electronics | 3 |
| 171 | Vessel Technology | 3 |
| 181 | Navigation I | 4 |
| 182 | Navigation II | 3 |
| 192 | Fishing Operations | 4 |

The University also offers graduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Hillier, Albert, Fishing Skipper, Assistant Professor of Fisheries and Marine Technology
McCauley, James A., B.S., Assistant Professor of Fisheries and Marine Technology
Meade, Thomas L., Ph.D., Associate Professor of Fisheries and Marine Technology
Merriam, Robert, M.S., Assistant Professor of Fisheries and Marine Technology
Motte, Geoffrey A., Master Mariner, Assistant Professor of Fisheries and Marine Technology
Sainsbury, John C., Ph.D., Chairman and Associate Professor of Fisheries and Marine Technology

To obtain further information, address all inquiries directly to:

Dr. J.C. Sainsbury, Chairman
Department of Fisheries & Marine Technology
210 Woodward Hall
University of Rhode Island
Kingston, Rhode Island 02881

## SAN DIEGO COMMUNITY COLLEGES
### CITY COLLEGE
### MESA COLLEGE
### EVENING COLLEGE
### SAN DIEGO, CALIFORNIA

These colleges each offer a two-year program leading to either an Associate Science degree or Certificate in Marine Technology. Shop facilities are utilized for practical instruction in refrigeration, welding, propul-

sion machinery, drafting, and other allied industrial arts that have relevance to marin work. Biological, physical and chemical laboratories are used for class work needed to develop skills related to basic tasks needed in the marine environment. Initially, instruction began in 1967 and the full program began in 1969. A wide range of marine science, ocean engineering, and business enterprises are carried on in San Diego, and many of these are frequently visited in the course of field trips. Vessels are chartered for all-day at-sea instruction. A shoreside technology institute jointly administered by a countywide alliance of higher education institutions will be constructed in 1974.

The following courses are offered in conjunction with the above programs:

MARINE TECHNOLOGY

| | | |
|---|---|---|
| 1 | Introduction to Marine Technology | 3 |
| 2 | Marine Technology Laboratory I | 3 |
| 3 | Marine Industrial Operations | 3 |
| 4 | Marine Construction | 3 |
| 5 | Equipment Operations | 1 |
| 6 | Marine Resources | 3 |
| 7 | Marine Communications | 3 |
| 8 | Seamanship and Engineering | 3 |

The instructional staff for the courses listed above consists of the following:

MARINE TECHNOLOGY DEPARTMENT

Eberhardt, Robert L. M.S., Instructor in Marine Technology

To obtain further information, address all inquiries directly to:

William Steinberg
Director of Vocation Education
San Diego Community Colleges
835 Twelfth Avenue
San Diego, California 92101

## SANTA BARBARA CITY COLLEGE
### SANTA BARBARA, CALIFORNIA

The College offers marine science and related technical courses on the main college campus, the industrial training facility in downtown Santa Barbara, and special private facilities in and adjacent to the harbor at Santa Barbara. A new Geology and Life Science building was completed in the spring of 1970 and includes modern laboratory facilities for Physical Oceanography, Biological Oceanography, and Marine Biology. A new Physical Science building was completed in 1965, and houses modern laboratory facilities for Technical Physics and Chemistry. The Industrial Trade Center, opened in the fall of 1968, houses modern laboratory facilities for machine-shop, welding, marine engines, and compressors and special deep water tanks for specialized training in underwater operations. Offshore instruction is conducted in operational work boats and research vessels on loan or rented from private industries.

The Associate in Science (Marine Diving Technician) is offered by the College. All students are required to complete all course work as required, including qualification as a working diver to depths of 200 feet. Each student must demonstrate a working knowledge of specialized courses dealing with communications, the science of the ocean environment. In addition, all students must demonstrate a working knowledge of small boat operations and maintenance, welding, drawing and blue print reading, machine shop operation, and compressor maintenance--as well as skills in the use of all types of underwater working gear.

The following courses are offered in conjunction with the above program:

ENGLISH DIVISION

| | | |
|---|---|---|
| 18 | Technical Report Writing | 3 |

FINE ARTS DIVISION

| | | |
|---|---|---|
| 5 | Business Speech | 3 |

MATHEMATICS DIVISION

| | | |
|---|---|---|
| 41 | Technical Algebra | 3 |
| 43 | Technical Trigonometry | 3 |

LIFE SCIENCE DIVISION

| | | |
|---|---|---|
| 5 | Marine Biology | 3 |
| 11 | Biological Oceanography | 4 |

PHYSICAL SCIENCE AND ENGINEERING DIVISION

| | | |
|---|---|---|
| 11 | Physical Oceanography | 4 |
| 12 | Technical Physics | 3 |
| 13 | Technical Physics | 3 |

SOCIAL SCIENCE DIVISION

| | | |
|---|---|---|
| 11 | Marine Law and Economics | 3 |

VOCATIONAL-TECHNICAL DIVISION

ELECTRONICS DEPARTMENT

| | | |
|---|---|---|
| 10 | Fundamentals of Electronics | 3 |
| 11 | Applications in Electronics | 3 |
| 14 | Instrumentation | 4 |

INDUSTRIAL TECHNOLOGY DEPARTMENT

| | | |
|---|---|---|
| 2 | Drawing and Blue Print Reading | 3 |

MACHINE SHOP AND WELDING DEPARTMENT

| | | |
|---|---|---|
| 11 | Machine Shop Operations | 4 |
| 3 | Combination Welding | 3 |

MARINE TECHNOLOGY DEPARTMENT

| | | |
|---|---|---|
| 1 | Introduction to Marine Technology | 3 |
| 2 | Basic Diving (Scuba and Hookah) | 3 |
| 3 | Advanced Diving | 3 |
| 4 | Fundamentals of Marine Engines & Compressors | 3 |
| 5 | Underwater Construction | 3 |
| 6 | Underwater Operations | 3 |
| 7 | Diver Tending | 3 |
| 11 | Summer Work Experience | 1-4 |
| 21 | Research Module (Independent Study) | 1-3 |
| 22 | Research Module (Independent Study) | 1-3 |
| 61A | Marine Technical Experience | 4 |
| 61B | Marine Technical Experience | 4 |
| 61C | Marine Technical Experience | 4 |
| 61D | Marine Technical Experience | 4 |

The instructional staff for the courses listed above consists of the following:

ENGLISH DIVISION

Stewart, Hazel M., M.A., Instructor of English

FINE ARTS DIVISION

Crawford, Barbara L., M.A., Instructor of Speech

MATHEMATICS DIVISION

Tlapa, Richard F., B.S., Associate Professor of Electronics

LIFE SCIENCE DIVISION

Jorgensen, William C., M.A., Assistant Professor of Life Science

PHYSICAL SCIENCE AND ENGINEERING DIVISION

Olsen, Phil G., M.A., Instructor of Geology
Schuler, Frederic W., Ph.D., Chairman and Assistant Professor of Physical Science

SOCIAL SCIENCE DIVISION

Sofas, Stanley C., M.A., Chairman and Professor of Social Science

VOCATIONAL-TECHNICAL DIVISION

Christensen, Robert W., B.S., Instructor of Marine Technology
Daniels, Arthur R., Master Machinist, Instructor of Machine Shop Operations
Parker, Jim G., A.S., Instructor of Marine Technology
Parks, H. Ramsey, A.S., Coordinator and Instructor of Marine Technology

To obtain further information, address all inquiries directly to:

James E. Foxx
Assistant Dean, Vocational Technical Education
Santa Barbara City College
721 Cliff Drive
Santa Barbara, California 93105

## SEATTLE CENTRAL COMMUNITY COLLEGE
### SEATTLE, WASHINGTON

The College offers Marine Engineering Technology courses at its new ship canal campus in central Seattle. This two-acre site has its own shore support classrooms and engineering laboratories, as well as the necessary deep water piers for docking the training vessel. "Hands-on" time is emphasized aboard the 189-foot, 1,260 ton training ship, S/S TRIDENT. Students become directly involved in the operation, maintenance, and inspection of marine systems aboard the training ship.

Associate Degree, Marine Engineering Technology. This program emphasizes the practical training necessary for the efficient operation and effective maintenance of sea-going vessels. As a rule, students find employment aboard fisheries vessels, ocean-going tugs, and ferries operating in the Pacific Northwest. Throughout the entire two years of coursework, laboratory experiments plus shipboard operations and maintenance accompany all theoretical studies. The program is designed to provide extensive and diversified training from the start. Currently, only "engine department" courses are offered.*

*It is anticipated that a "deck department" program will be inaugurated for the 1971-72 school year.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| MTE 101 | Engine Department Maintenance | 4 |
| MTE 102 | Auxiliary Machinery | 4 |
| MTE 106 | Ship's Machine Shop Practice | 2 |
| MTE 111 | Marine Electricty | 4 |
| MTE 112 | Marine Electricty | 4 |
| MTE 113 | Marine Electricty | 4 |
| MTE 122 | Marine Hydraulics | 3 |
| MTE 123 | Marine Hydraulics | 3 |
| MTE 131 | Boilers | 2 |
| MTE 132 | Boilers | 2 |
| MTE 140 | Maritime Law | 3 |
| MTE 141 | Maritime Economics | 3 |
| MTE 142 | Labor Relations | 3 |
| MTE 148 | Ship's Medical Practice | 2 |
| MTE 151 | Reciprocating Engines | 2 |
| MTE 171 | Diesel Engines | 3 |
| MTE 181 | Basic Marine Refrigeration | 3 |
| MTE 241 | Gas Welding | 3 |
| MTE 242 | Arc Welding | 3 |
| MTE 251 | Turbine Engines | 3 |
| MTE 252 | Turbine Engines | 3 |
| MTE 271 | Diesel Engines | 3 |
| MTE 272 | Diesel Engines | 3 |
| MTE 281 | Marine Refrigeration Systems | 4 |
| MTE 290 | Coast Guard Rules and Regulations | 3 |
| MTE 293 | Instrumentation | 3 |
| MTE 299 | Engineering Graphics and Blueprint Reading | 3 |

The instructional staff for the courses listed above consists of the following:

DEGREE

Dahlgren, H. Kenneth, Instructor, Marine Engineering Technology; Licensed Professional Engineer; Licensed U.S.C.G. Chief Engineer
Smith, Donald W., Department Chairman, Marine Engineering Technology; M.S.; U.S.C.G. Licensed Marine Engineer

OCCUPATIONAL EXTENSION

Campion, Robert, Instructor
Dahlgren, H. Kenneth, Instructor
Klones, Daryl, Instructor
Zandee, Peter M., Instructor

To obtain further information, address all inquiries directly to:

Registrar
Seattle Central Commumity College
1718 Broadway
Seattle, Washington 98122

## SHORELINE COMMUNITY COLLEGE
### SEATTLE, WASHINGTON

Instruction in marine instrumentation, biological instrumentation, computer training, and engineering is coordinated within the Biological Science Building, Chemical

Science Building, Physical Science Building, library and electronics facilities. Research vessels used by the college for on-the-job training requirements are provided by the University of Washington and the National Oceanic and Atmospheric Administration.

The Associate Degree in Applied Arts and Sciences, Marine Biology Technician and the Associate Degree in Applied Arts and Sciences, Oceanographic Technician are offered by the College. All students are required to obtain on-the-job training experience from three to six months aboard ship or in a research lab situation and to complete with a 2.0 GPA 90 hours of course instruction in the applied marine sciences as indicated in the college curriculum.

The following courses are offered in conjunction with the above programs:

| | | |
|---|---|---|
| Bio 101 | Principles of Biology | 5 |
| Bio 103 | Principles of Biology | 5 |
| Bio 201 | Topics in Microbiology | 5 |
| B.T. 195 | Biological Techniques | 5 |
| B.T. 197 | Basic Biological Laboratory Procedure | 5 |
| Chem 101 | General Chemistry | 5 |
| C.T. 190 | Gravimetric and Volumetric Methods | 6 |
| C.T. 191 | Electroanalytic Methods | 6 |
| C.T. 192 | Optical and Chromatographic Methods | 6 |
| Zoo 111 | General Zoology | 5 |
| Zoo 112 | General Zoology | 5 |
| P.E. 140 | Scuba Diving | 1 |
| P.E. 240 | Advanced Scuba Diving I | 2 |
| P.E. 241 | Advanced Scuba Diving II | 2 |
| EET 140 | Electronics for Technicians | 4 |
| EET 141 | Electronics for Technicians | 4 |
| EET 150 | Technical Drawing I | 5 |
| EET 155 | Elementary Surveying | 5 |
| EET 170 | Civil Drafting-Cartography | 5 |
| EET 275 | Photogrammetry | 3 |
| M.T. 102 | Machine Tool Fundamentals | 3 |
| M.T. 103 | Machine Tool Practices I | 3 |
| M.T. 115 | Welding and Foundry Fundamentals | 3 |
| Math 101 | Intermediate Algebra | 5 |
| Math 181 | Introduction to Probability and Statistics | 4 |
| Math 200 | Introduction to Computer | 2 |
| T.M. 191 | Mathematics for Technicians | 4 |
| Oc 101 | Survey of Oceanography | 5 |
| O.T. 174 | Underwater Photography | 1 |
| O.T. 196 | Oceanographic Instrumentation Techniques | 4 |
| O.T. 197 | Oceanographic Instrumentation Techniques | 4 |

The instructional staff for the courses listed above consists of the following:

Harman, Robert A., M.S., Assistant Professor, Geology, Oceanography
Lewis, Billy G., M.S., Assistant Professor, Science
Serwold, John C., M.S., Associate Professor, Life Sciences
Willard, Stanley G., M.A., Assistant Professor, Chemistry

To obtain further information, address all inquiries directly to:

John C. Serwold, Associate Prof.
Life Sciences
Shoreline Community College
Seattle, Washington 98133

## SOUTHERN MAINE VOCATIONAL TECHNICAL INSTITUTE
### SOUTH PORTLAND, MAINE

Facilities at the Institute include a recently acquired training vessel "ELY" (186-feet, steel hulled); Seamanship Lab.; Marine Engineering Lab., which includes Engineering Lab., Fuel Injection Lab., Electrical Lab., and Engineering classroom; Physics Lab.; Mechanics Lab.; Heat-Sound-Light-Electrical Lab.; Chemistry Lab., located in the new science building, Hildreth Hall; Marine Biology and Oceanography Lab.; and library facilities with up-to-date book collections.

Students spend a percentage of the school year at sea on the training vessel. Many methods of instrumentation and shipboard laboratory techniques in oceanography are included as part of the course. Eight weeks of each semester, students are required to participate in sea trips. Such participation includes deck, engine room, and oceanographic station watch. Discipline aboard the vessel meets the rigid demands of maritime requirements.

The Institute is ideally located on Casco Bay overlooking the Gulf of Maine with its vast continental shelf resources. Thus the greatest possible advantage may be gained by our students in the learning and practicing of field techniques in the Marine Sciences. The program will emphasize field work in the form of observing, collecting and surveying, using the most recent instruments and latest methods. The students will receive detailed training and practice in laboratory procedures commonly associated with marine resource study and development.

1. Associate Degree in Applied Marine Biology & Oceanography. A student expecting to enter the Applied Marine Biology and Oceanography field must have a strong desire to work out-of-doors and aboard ship. He should be prepared both mentally and physically for the sometime rigorous demands that will face him. He should be interested in working closely with others as a team member. He should obtain a high school diploma and should be advised to take at least two years of Algebra, one year of Chemistry, Biology, Physics, or the equivalent. Acceptable GATB (General Aptitude Test Battery) and SAT (Scholastic Aptitude Test) scores and the Mathematics Level I and English Achievement Scores must also be presented. Students in the degree program take all college-level courses (physical, chemical, and biological oceanography), as well as mathematics and the humanities required for an Associate Degree. These students may also pursue their education in this field beyond the Associate Degree level.

2. Associate Degree or Non-Degree Industrial Marine Science Program. The enrollment of a student in a degree or non-degree industrial program depends on his academic background and ability to carry on related subjects. In the industrial program, ultimately the student receives his degree by acquiring additional courses in the humanities and the natural sciences. Second-year students specialize in either the oceanography and deck, or engineering and oceanography phase of the course, resulting in a more concentrated and comprehensive study of the selected subject area. Following the second semester, the student will determine which of the two programs he will pursue. Following completion of the program, the student is pre-

sented with a wide range of opportunities for profitable employment. Graduates become associated with various oceanographic firms, the United States Government, oil companies, fisheries, and other marine oriented organizations.

The following courses are offered in conjunction with the above programs:

APPLIED MARINE BIOLOGY & OCEANOGRAPHY

| | | |
|---|---|---|
| Bio 111 | Biology | 4 |
| Oco 111 | Elements of Oceanography | 4 |
| Oco 112 | Instrumentation and Methods in Oceanography | 4 |
| Zoo 112 | Invertebrate Zoology | 4 |
| Nav 21 | Survey of Navigation | 3 |
| Bio 211 | Field Biology (Ecology) | 4 |
| Oco 211 | Chemical Oceanography | 4 |
| Bio 222 | Microbiology | 4 |
| Oco 212 | Physical and Geological Oceanography | 4 |
| *Electives | | |
| Bio 242 | Planktology | 3 |
| Bio 244 | Histology | 3 |
| Bio 246 | Marine Botany | 3 |
| Bio 248 | Fish Science | 3 |

INDUSTRIAL MARINE SCIENCE

| | | |
|---|---|---|
| Bio 111 | Biology | 3 |
| Oco 111 | Oceanography I | 3 |
| MS 111 | Engineering I | 3 |
| MS 113 | Deck Technology I | 3 |
| Bio 112 | Marine Biology I | 3 |
| Oco 112 | Oceanography II | 3 |
| MS 112 | Engineering II | 3 |
| MS 114 | Deck Technology II | 3 |
| Bio 211 | Marine Biology II | 3 |
| Oco 211 | Oceanography III | 4 |
| MS 211 | Engineering III or | |
| MS 215 | Deck Technology III | 6 |
| Oco 212 | Oceanography IV | 4 |
| MS 212 | Engineering IV or | |
| MS 216 | Deck Technology IV | 6 |

*These courses are offered in all phases of Marine Science Programs.

The instructional staff for the courses listed above consists of the following:

Acheson, Richard D., Instructor, Microbiology
Arlander, Richard P., Instructor, Marine Science
Banerjee, Tapan, Chairman and Coordinator of Marine Science Dept., Marine Biology and Oceanography
Colpitts, Lawrence H., Captain, Marine Science
Doughty, Aftin L., Assistant Engineer, Marine Science
Eayrs, Weston III, Instructor, Oceanography
Goode, Robert E., Instructor, Marine Biology
Hall, Charles M., Instructor, Marine Science
Hupper, George W., Instructor, Marine Science
Knowles, Dennis T., Instructor, Chemistry
Knowles, George B., Instructor, Marine Science
Lomoriello, Luigi S., Instructor, Marine Science
Siegel, Robert E., Instructor, Oceanography
Soucy, Robert C., Instructor, Marine Science
Turner, Norman W., Chief Engineer of Vessels, Marine Science

To obtain further information, address all inquiries directly to:

Mr. Tapan Banerjee, Chairman and Coordinator
Marine Science Department
Southern Maine Vocational Technical Institute
Fort Road
South Portland, Maine 04106

## SUFFOLK COUNTY COMMUNITY COLLEGE
### SELDEN, L. I., NEW YORK

In addition to normal chemistry and biology laboratories, the following are used in teaching Marine Technology: a Sea Skiff 29-foot Cruiser, a Boston Whaler, a Special Marine Laboratory equipped with modern equipment, a 50 acre marine study area with two buildings, and the use of a Campus Computer Center.

The fundamental goal of the program is to provide qualified high school graduates with two years of coordinated technical and general education courses at the college level in order to enable them to function as technicians in marine and allied industries. A graduate of this program receives an Associate in Applied Science Degree, and is prepared to assume the duties of a marine technician.

The following courses are offered in conjunction with the above program:

| | | |
|---|---|---|
| MR 11 | Commercial Fishing Techniques | 2 |
| MR 22 | Navigation | 3 |
| MR 25 | Elements of Oceanography | 4 |
| MR 30 | Marine Ichthyology | 3 |
| MR 35 | Applied Microbiology | 3 |
| MR 40 | Commercial Marine Products | 3 |
| MR 45 | Elements of Marine Ecology | 4 |
| MR 50 | Shellfish | 4 |
| CH 25 | Marine Technology Chemistry I | 4 |
| CH 26 | Marine Technology Chemistry II | 4 |
| BY 33 | Modern Biology I | 4 |
| BY 34 | Modern Biology II | 4 |
| DP 55 | Computer Programming - FORTRAN IV | 3 |

The following courses are offered for other students:

| | |
|---|---|
| MB 21 | Marine Biology |
| OC 15 | Introduction to Oceanography |

The instructional staff for the courses listed above consists of the following:

Black, John A., B.A., Instructor
Kirchner, Carl, Ph.D., Professor
Sherrill, Edwin L., A.A., Technical Assistant
Smith, Walter L., M.S., Professor, Head of Department of Marine Science and Technology
White, Harry H., Technical Assistant

To obtain further information, address all inquiries directly to:

Walter L. Smith, Professor
Head of the Department of

Marine Science & Technology
Suffolk County Community College
Selden, Long Island, New York 11784

## WASHINGTON TECHNICAL INSTITUTE
WASHINGTON, D. C.

Courses are offered at the Van Ness campus, 4100 Connecticut Avenue. The purpose of the program is to train marine technicians by giving them a general understanding of the atmosphere, hydrosphere, and lithosphere, and by familiarizing them with the commonly used instrumentation and observations to be collected.

The Associate of Science is offered by the Institute.

The following courses are offered in conjunction with the above programs:

ENVIRONMENTAL SCIENCE TECHNOLOGY

| | | |
|---|---|---|
| MARS 101 | Physical Geography | 3 |
| MARS 102 | Physical Geography | 3 |
| MARS 103 | Physical Geography | 3 |
| MARS 210 | Marine Instrumentation | 6 |
| MARS 204 | Oceanography | 3 |
| MARS 205 | Oceanography | 3 |
| MARS 220 | Data Recording and Handling | 6 |
| MARS 230 | Maintenance | 9 |

GENERAL STUDIES

| | | |
|---|---|---|
| DEVL 176 | Development and Orientation | 1 |
| ENGL 114 | Communications | 3 |
| ENGL 115 | Communications | 3 |
| ENGL 120 | Technical Writing | 3 |
| SOCS 121 | Social Studies | 3 |
| SOCS 122 | Social Studies | 3 |
| SOCS 123 | Social Studies | 3 |

SCIENCE TECHNOLOGY

| | | |
|---|---|---|
| MATH 111 | Technical Mathematics | 3 |
| MATH 112 | Technical Mathematics | 3 |
| MATH 113 | Technical Mathematics | 3 |
| PHYS 111 | Physics | 4 |
| PHYS 112 | Physics | 4 |
| PHYS 113 | Physics | 4 |
| CHEM 111 | General Chemistry | 4 |

ENGINEERING TECHNOLOGY

| | | |
|---|---|---|
| ELEC 101 | Basic Electricity | 4 |
| ELEC 102 | Basic Electricity | 4 |
| ELEC 103 | Basic Electricity | 4 |
| ELEC 221 | Solid State Tech | 3 |

The instructional staff for the courses listed above consists of the following:

Backus, Charles W., Instrumentation Specialist
Elliott, F. E., Ph.D., Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dr. F. E. Elliott
Washington Technical Institute
4100 Connecticut Avenue, N.W.
Washington, D.C. 20008

# *APPENDIX*

# *INSTITUTIONS BY GEOGRAPHIC LOCATION*

# APPENDIX

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